SCIENTIFIC AMERICAN

BURNING AND BLOWING UP OF THE "GOOD HOPE" IN THE ENGAGEMENT OFF THE CHILEAN COAST BETWEEN THE GERMAN AND BRITISH SQUADRONS.—[See page 420.]

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

Entrenched Troops Versus 16-inch Mortars

THE 16-inch mortar, conceived and brought into existence behind a veil of strict secrecy at the Krupp works, was Germany's answer to the frontier forts of the French line of defense. We all know what happened when this latest exemplification of the irresistible force and the immovable obstruction met. The German giant with its smaller brethren, the Austrian 12-inch and the German mobile 11-inch pieces, cut their way through the Belgian and French fortifications with something of the ease with which a keen knife divides a pat of butter. Had the momentum of the German rush through northern France been sufficient to carry the masses of German infantry up to the ring of permanent fortifications encircling Paris, these same mammoth siege pieces would have been emplaced to the rear, and, with sure and swift deliberation, they would have cut an open road for the German army right into the very heart of Paris itself.

We have pointed out more than once in these columns that, in the history of warfare, every novel means of attack has found an adequate means of defense developed to meet it; but when the story of Liège, Namur, and Maubeuge was made known, it seemed as though Germany had for once secured the whip hand, by producing an engine of attack to which no adequate reply could be made.

Nevertheless, even in the case of this stupendous weapon, it begins to look as though history would repeat itself in the matter of defense; for an effective answer to the 16-inch siege gun has been found in the infantryman with his rifle and entrenching tools. And herein is to be found an explanation of the fact that such great barrier fortifications as those at Verdun are to-day standing intact against the German invasion. For had the Germans been able to carry their lines of entrenched infantry, with their supporting field artillery and machine guns, sufficiently close to these fortresses to make possible the emplacing of their heavy siege artillery well to the rear but within striking range, these fortresses would have crumpled up under the attack many weeks ago. The desperate fighting, the endless attack and counter-attack, which have been taking place between the German and French hosts around Verdun, has been a struggle for the possession of that perimeter of the surrounding terrain, within which the German siege artillery must be emplaced if Verdun is to be taken.

And so there has come about a most curious inversion of the intended relation of permanent fortifications and troops. Instead of the fortress protecting the troops, the troops are protecting the fortress—which may be taken as another evidence of the fact, recently alluded to in these columns, that the day of permanent fortifications is practically over.

Failing an opportunity, for the present at least, to use these guns for their intended purpose, the Germans are emplacing them in the rear of their entrenched infantry and are using them for the attack of field entrenchments—another curious development of the war. Used under these conditions, their effect is more moral than material. A costly 16-inch shell, one successful hit with which will turn a powerful Gruson fort into a rubbish heap, is a good investment; but a 16-inch shell dropping on soft ground and producing a solitary, if very formidable-looking crater, here and there along a stretch of three hundred miles of field entrenchments, is not to be regarded as making a very good return upon the money invested. For the shelling of entrenchments, occupied villages, or open cities, the greater volume of fire delivered by the lighter German howitzers is far more effective than the occasional dropping of one of these monster projectiles. The great range of the mortars is, of course, a valuable asset; but an equal range could be obtained by the smaller and more rapidly firing howitzers, by increasing the caliber-length, the powder pressure, and the muzzle velocity. In the case of the smaller pieces, there would be the great practical advantages of swift mobility, rapid emplacement, and, as we have said, a vastly greater volume and rapidity of fire.

If the French and English should succeed, like the Russians, in rolling the tide of invasion back over the German frontiers, the Allies will be confronted with the same difficulties, in bringing their heavy siege artillery to bear upon the German fortifications. There will have to be, in every case, a bitterly contended fight for the emplacement sites, before the reduction of the fortresses can be undertaken.

All of which goes to prove, once more, that the man is ever greater than the machine.

A Few Thoughts on Man

THE Scottish Shorter Catechism asks the question, What is the chief end of man? It goes on to ask a number of other questions, all more or less interesting, and in most cases the questions are much more illuminating than the answers. But this question seems the most significant of them all. The answers to it appear somehow even less conclusive than the answers to other questions. Of course, by continually asking why, any philosopher can be nonplussed about anything, as most people who have had much to do with children are perfectly aware. A few childish questions can reduce all learning to futility.

Science has practically given up answering whys and contents itself with describing hows. If you ask a scientific man why a stone falls to the ground, he will tell you that he doesn't know. Not long ago he would have replied that it fell to the ground because the earth and stone attract one another. This is very much the same as saying that an unsupported stone falls to the ground because, as has been ascertained by frequent experiments, an unsupported stone falls to the ground. But if you ask a scientific man *how* a stone falls to the ground, his intelligent countenance will light up at once and he will talk for a long time. He will talk about the acceleration of the stone, mention Newton, and say something which sounds complicated about inverse square of the distance and directly as the masses. In short, Newton's law of gravitation tells how bodies approach one another, but does not profess to say why they approach one another. There are some ingenious gentlemen, many of whom live in France, who think that is all Science can do, and perhaps they are right.

It is rather important that the modern scientific attitude about these things should be understood. Misunderstandings have arisen because it has not been understood. For instance, Mr. G. K. Chesterton, usually an entertaining and valuable writer, has written, through ignorance, quite a lot of nonsense about science. Among other things, he says that scientific men "imagine a necessary mental connection between an apple leaving the tree and an apple reaching the ground." Scientific men do nothing of the kind. Mr. Chesterton is speaking of the superior logic of fairy tales, and the real scientific man is quite willing to meet him on this ground. A scientific man has no objection to saying that the apple is inhabited by a fairy whose somewhat monotonous idea of amusement, or whose inflexible sense of duty, causes it to make the apple reach the ground whenever the apple is unsupported. Of course, the scientific man would require evidence for this, and he would point out that the path followed by the apple and the acceleration imparted to it by the fairy, were in accordance with Newton's law of gravitation. He asserts that Newton found a formula describing how the apple reaches the ground, but not why it reaches the ground.

But to return to the Scottish Shorter Catechism, the question, What is the chief end of man? is in itself a little ambiguous. We may take the word man to mean man individually or to mean the human race. Taking the question to have the former significance, it seems to be thought by some writers that man's chief end is to make himself a means. The next generation is to be made better by our efforts, and that is to make the next generation better and so on, until finally perfection is reached, or the race comes to an end. When perfection is reached, the race presumably occupies its time in maintaining itself perfect. It may have occurred to some writer of this school to show that perfection can never be reached, but can be more and more closely approached, like the limit which represents the sum of an infinite series. This does away with the bother of describing how the generations which reach perfection fill in their time.

This answer does not satisfy, but there is nothing more satisfactory to put in its place. It is hard to believe that all the activities of this generation are to be judged according to their effect on the next. And the answer is not a practical one because it ignores philosophy. We might agree to help make the next generation better, but our notion of what is better might be very different from those of other people. It might be, as one will easily agree after a little study of some pessimistic philosophers, that there are people who think the best thing to do for the next generation is to prevent its coming into existence. Even if we agree to let the next generation exist, we might disagree about how it is to exist. It depends on our theories. One might insist on healthy children. If we believed some writers, we should insist on unhealthy children, because they have keener spiritual perceptions, and spiritual perceptions are more desirable than anything else. If Nordau is right, and geniuses are insane, then perhaps we should encourage insanity. The answer given in the Catechism itself to the question conveys nothing whatever. None of the chief terms are intelligible. But the other answers convey hardly more, so perhaps the orthodox answer is as good as the others. It may be better. It may be incomprehensible because it is true.

Accessibility in Motors

A FEW years ago there seemed to be a perfect rage in this country for motorcars in which every part of the motor was "accessible"; that is to say, at the mercy of every driver or new owner who wished to emulate the little boy and his desire to see "what makes the wheels go round." To-day the shrewd automobile manufacturer incloses every vital part of the car in such a shell of steel, that it is prone to discourage the would-be tinkerer. The modern passenger-carrying automobile should be left severely alone by the untrained man; it takes an expert mechanic to take it apart and put it together again!

On the other hand, the commercial motorcar should be as accessible as possible, and of such standardized and interchangeable parts as to make quick repairs easy of attainment. The European war, in the first few months, has taught the British and French a few lessons about standardization and accessibility which they are not liable to forget. Single trucks and whole convoys have been lost because of the inability of the driver to make replacements and exchanges of magneto parts and other important units of the machines. Drivers of subsidized trucks in the war are supposed to be mechanics, and capable of making ordinary repairs on the road; the private owner of a touring car usually is not qualified to do such work. If, therefore, the war experience proves the value of accessibility in the motor of a truck, it does not change the opinion of the automobile trade as to the necessity of protecting the motor of a pleasure car from tinkering by untrained hands.

Interplanetary Masses of Gas

IT is suggested that some of the striking changes manifested by certain comets in executing their orbits are due to the fact that they encounter masses of gas in interplanetary space, and that they are not moving in a vacuum. If there are such gaseous masses, then in view of the inclinations and extent of their orbits, comets are peculiarly fitted to act as explorers, and there is every probability that they would sooner or later encounter such masses.

The planets move in a narrow zone near the plane of the ecliptic, while the inclination of the cometary orbits is sometimes considerable, varying for the periodic comets from 3 degrees to 162 degrees. As a consequence comets attain regions of the solar system where no other bodies penetrate. Many phenomena seem to receive a satisfactory explanation if the existence of gaseous masses scattered through the solar system be admitted. These gaseous masses, probably of different chemical constitution, may be considered as the residue of the initial nebula, having escaped the phenomena of combustion which gave rise to the other members of the solar system.

Rinderpest in the Philippines.—Rinderpest, which has decimated the carabao in the Philippines for many years in spite of energetic quarantine measures, will probably be stamped out entirely before long, if the new plan under consideration of immunizing the cattle against this disease should prove successful. An official test recently made on 8,000 animals proves that permanent immunity can be attained by a simple process, at a cost of not more than 50 cents a head, and with a loss of less than 1 per cent of the animals treated. It is estimated that all the cattle in the infected provinces could be immunized in two or three years at a total cost of not more than $100,000, which is about half what the government now spends each year for quarantine, while $75,000 would insure owners against loss by the immunizing process. A further expense of $50,000 a year would provide for the inoculation of all young stock and imported cattle.

Engineering

German Floating Crane at Panama.—The new floating crane Ajax of 270 tons capacity, which was recently imported from Germany, is now ready for its test at Panama. Before long the sister crane Hercules will be afloat. These two are said to be the largest floating cranes in the world.

An Opportune Fund.—A fund of $50,000 for "promoting commerce in Central and South America" which has just become available to the Department of Commerce should be of material assistance in teaching the expected infant, our merchant marine, to walk as soon as the shipping bill and government insurance are in working order.

To Fly the American Flag.—Since the passage of the act of August 18th, eighty-one foreign-built vessels of 285,268 gross tons have been admitted to American registry. Of these, nineteen are passenger steamships, and sixty-one are freight vessels. According to Commissioner Chamberlain, additional ships are being added to the American registry every week. Sixty-eight of the above vessels were formerly under the British flag, eight were German and five were Belgian vessels.

Proposed Baltic and Black Sea Canal.—The commission appointed by the Russian Duma and Senate four years ago has reported favorably on the proposed Baltic and Black Sea canal scheme. It is proposed to canalize the Dnieper and the Dwina, the former flowing into the Black Sea at Kherson, and the latter into the Gulf of Livonia and the Baltic Sea at Riga. The sources of the two rivers at the divide would be connected by artificial waterways. The length of the canal would be 1,540 miles.

Belt Railway for Peking.—The Chinese Ministry of Communications has completed an arrangement with the city authorities of Peking to establish a line seven miles long, which will hug the wall its whole length, and connect the terminals of the Peking-Kalgan, Peking-Mukden, Peking-Tung-chow and the Peking-Hankow railways. Two tunnels will be bored on either side of the existing arch forming the Chien-men; one will be used for the proposed tramways and the other for passenger traffic.

Fuel Oil Experiments on the Railways of Chili.—The Chilian Government which has had under consideration for some time the installation of oil-burning equipment on all the government-owned railways of the country, has decided to turn over one entire division of the Longitudinal Railway, about 125 miles long, for exhaustive experiments. The proposition was worked up and will be carried out by engineers from the United States. The consumption of fuel oil in Chili has increased since 1904 from 5,600 tons to over 230,000 tons last year.

Panama Canal and Transcontinental Freight.—The influence of the Panama Canal upon the movement of freight by rail has been greater than was anticipated and the amount of tonnage which is being sent through the canal is a matter of surprise to those who are accustomed to the handling of transcontinental freight. Since August 15th, when the canal was opened for business, over fifty ships varying in size from 6,000 to 12,000 tons have been carrying through the canal freight consigned to the Pacific Coast. A considerable proportion of this is being moved, even from as far West as Ohio, by the way of New York and the canal to Pacific coast points. As instances of this we note that 15,000 tons of wrought iron pipe have been shipped by the canal route from Youngstown, Ohio, to San Francisco. The all-rail price is 65 cents per hundred weight; by way of New York and by the canal it is 48 cents. Canned corn is being shipped through the canal from the Indiana canneries to the Pacific Coast, as is also cast iron pipe, sent from Alabama via New Orleans.

Road Models.—At the Fourth American Road Congress, held at Atlanta, November 9th-13th, the U. S. Department of Agriculture exhibited a complete set of models illustrating the construction and maintenance of standard types of roads. Included in this set were models showing the development of stone road building for 2,000 years past, among which were the Appian Way, representing an ancient Roman type of construction, samples of early French roads, the Telford, and early and modern Macadam roads. Other models shown illustrated questions of road location, bad alignment, improper grades, dangerous crossings, unsafe bridges and many other features necessary to understand when laying out good roads. The whole field of road building was covered, and it was the most complete educational exhibit ever attempted in this country. All of these models made on a scale of 1 inch to the foot, were large enough to perfectly illustrate their point. Besides the models an automatic projectoscope presented self reading lantern slides, while sets of motion picture films showed various construction scenes. This Congress was the most important and successful yet held, and accomplished encouraging work in the way of enlightenment and stimulating public interest in this important movement.

Science

Henry Gannett, of the U. S. Geological Survey, who died in Washington on November 5th, was the dean of American geographers, and a commanding figure in the scientific community at the National Capital. He was born at Bath, Me., in 1846, and educated at the Lawrence Scientific School and the Hooper Mining School of Harvard University. During nearly the whole of his professional life he was connected with the Geological Survey and its predecessor, the Hayden Survey of the Territories, having been chief geographer of the Geological Survey since 1882. He was especially identified with building up the admirable map-making work of that institution. Gannett wrote or edited a remarkable number of government publications which have become classical—such as the Dictionary of Altitudes (in several editions), the Statistical Atlases of the 10th, 11th, and 12th Censuses, the Manual of Topographic Methods, and a number of state gazetteers and geographic dictionaries. He was one of the founders of the National Geographic Society, and its president at the time of his death; chairman of the U. S. Geographic Board (formerly the Board of Geographic Names); and a member of many learned societies. He served as director of the Philippine Census in 1902, and of the Cuban Census in 1907-08.

The Killing of Plant Tissue by Low Temperature is the subject of a bulletin recently published by Mr. W. W. Chandler, of the University of Missouri, which includes results of elaborate observations of his own, covering a period of about ten years, and also a resume of the work done by others in the same line. Exact information as to the conditions under which plant tissue freezes beyond recovery is urgently needed, to serve as the basis of efficient and economical methods of protecting fruit and other crops from frost injury. Much valuable work has already been done by Goeppert, Sachs, Muller-Thurgau, Molisch, Gorke, Lidforss, Maximow, and other Europeans, but comparatively little in the United States; hence Mr. Chandler's investigations are especially noteworthy. Some of the principal results are as follows: Most tissues are more likely to survive the effects of low temperature on account of a subsequent slow rate of thawing. The chief exceptions to this statement are ripe apples and pears, and the leaves of Agave Americana and lettuce. In the case of fruit buds, blossoms, and young fruit the rate of thawing appears to be of no importance. This conclusion differs radically from the belief of most horticulturists. Fruit buds and the newly set fruit resists cold better than the half-grown fruit. (This is stated especially of peaches). Although increase in sap density (strength of the sap solutions) increases the power to resist cold, and this can be effected by slow wilting or the partial withholding of water through a long period, it is found that rapid wilting has no such effect. The most important feature affecting the hardiness of plant tissue is maturity, i. e., the condition of resistance that the plants reach during the winter dormant period. Several other interesting conclusions are drawn from the voluminous observations made on a variety of fruits and vegetables, and the author suggests numerous practical applications.

Solar and Lunar Halos form the subject of several important memoirs in the July number of the *Monthly Weather Review* (issued in November), constituting, in the aggregate, the most substantial contribution hitherto made in America to the literature of this fascinating but neglected subject. Interest in phenomena of this class has been greatly stimulated by the wonderful display of solar halos seen at various points in the eastern half of the United States on November 1st and 2nd, 1913, and this particular display is described and discussed in the Review by Dr. Louis Besson, of the Observatory of Montsouris, Paris, who is probably the highest living authority on halos. The halos were especially well developed in Missouri and Arkansas on the 1st, and in southern Virginia on the 2nd, including such extremely rare features as the halo of Hevelius, the anthelion (a white mock-sun opposite the real sun in azimuth and at the same altitude as the latter; not the "anthelion" of the dictionaries), paranthelia, and especially the oblique arcs of the anthelion. Besson furnishes a tentative explanation of the last-named phenomenon, but the subject cannot be fully cleared up until more and better observational data are available. The same number of the *Review* contains a translation of a memoir by Besson on "The Different Forms of Halo and their Observation," the original of which was published three years ago in *L'Astronomie*. As a description of all known forms of halo and a manual for observers this memoir is absolutely unique, and fills a long-felt want; it will probably diminish the number of bungling reports of halos published in the scientific journals, in which these meteors are referred to as "rainbows" and otherwise described with no regard whatever for established terminology. Lastly, the *Review* contains a memoir by Andrew H. Palmer on "Halos and their Relation to the Weather," which furnishes the explanation of several common weather proverbs concerning "circles 'round the moon," and kindred phenomena.

Aeronautics

Life-Saving Garment for Aviators.—David Williams Ogilvie, of Balboa, Canal Zone, in a patent, No. 1,109,140 presents a life-saving garment especially designed for aerial operators and which has means for retarding a fall, means to cushion against injury from a fall, and float means to act as life preserver if the operator should drop in the water.

An Open and Shut Aerodrome.—In patent, No. 1,109,648, to Wilhelm Kauertz, of Dusseldorf, Germany, is shown a hall for airships which is divided longitudinally into two halves opening toward each other and pivoted at their inner ends so they may swing apart and permit an airship to alight between them and then be adjusted together to enclose the airship.

An Automatic Aeroplane for War Purposes.—John Stasiak, of Seattle, Wash., has patented an aeroplane, No. 1,108,941, especially designed for use in war. It has an automatic control mechanism which can be set when the device is started on its journey and which predetermines the length of the journey at the end of which automatically operating means drop a bomb and automatically reversing and returning means are brought into play to return the aeroplane to its starting point and to shut off the power when such starting point is reached on the return.

Making Repairs 6,000 Feet in the Air.—While engaged in dropping bombs upon Antwerp one of the German Zeppelins was made the target for a Belgian battery, with the result that one of her propeller frames was badly damaged. This seriously interfered with the operation of the ship, and although it is said to have been 6,000 feet up, one of the mechanics of the crew climbed out on the injured framework, and in the course of half an hour cut away the damaged parts that prevented the machinery being operated. After this feat, while the ship was racing away at high speed, the same man repaired a long rent in the hull that had been made by a shell.

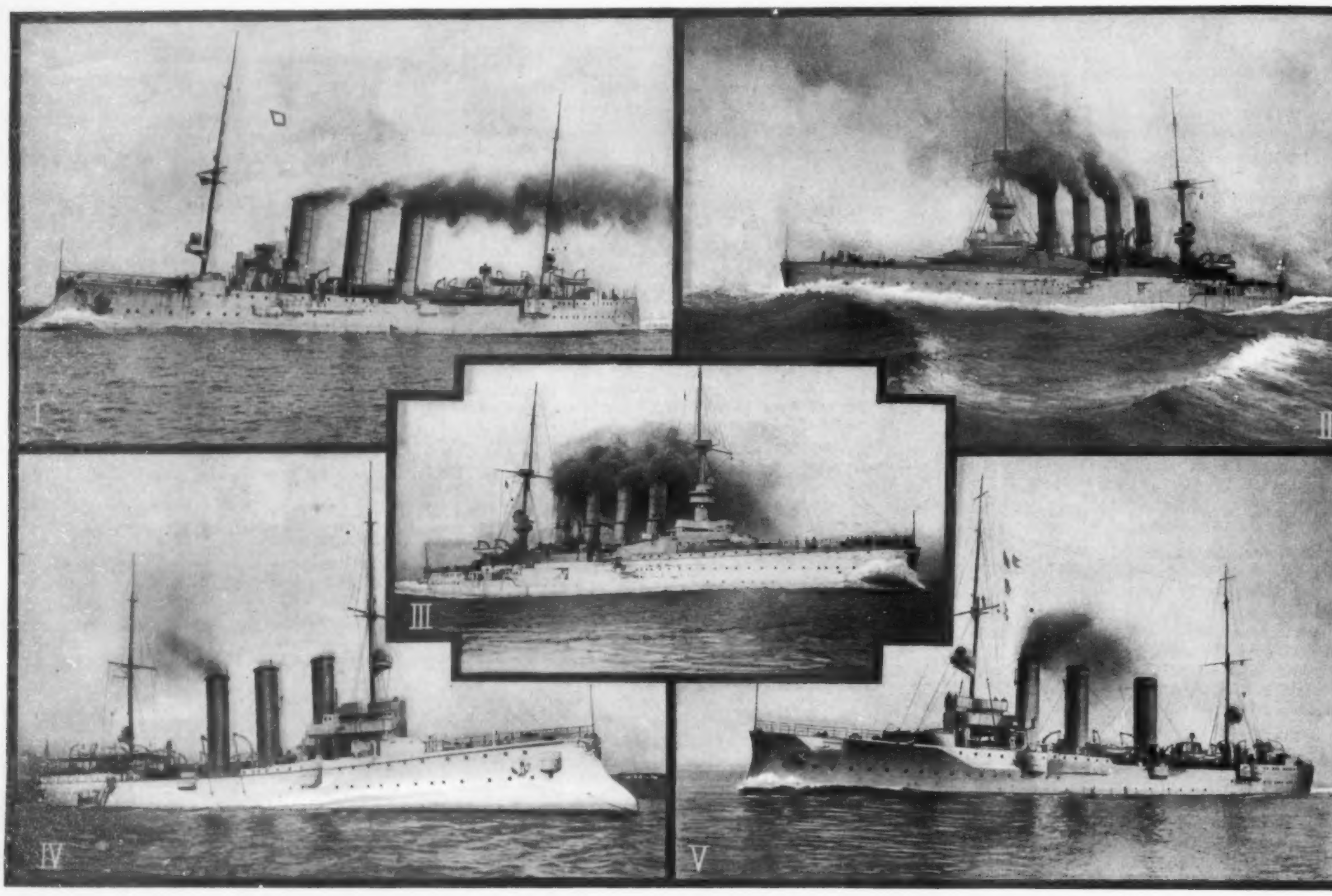
Awards in the English Aero Engine Competition.—The result of the military and navy competition has been the awarding of the £5,000 prize to the Green Engine Company, which best met the stringent requirements. This engine of 100 horse-power, has steel cylinders of 140 by 152 millimeters (about 5.51 by 5.98 inches), water cooled with copper jackets, and valves in the head operated by an overhead cam shaft. The total weight of this engine is 450 pounds. Eight other firms, whose engines successfully survived the preliminary eliminating run of six hours under full power, received awards of £100 each. These firms were Argyle (Ltd.); Beardmore Austro-Daimler Engine Company; British Anzani Engine Company; Dudbridge Ironworks Company; Gnome Engine Company; Green Engine Company; Sunbeam Motor-Car Company, and Wolseley Tool and Motor Car Company.

Wright Patents Recognized in England.—Word comes from England that the British Government has recognized the validity of the Wright patents covering certain features of aeroplanes, and has paid to the representatives of the Wright interests the sum of £15,000 to cover both past and future use of the devices protected. This settlement was brought about by the service of papers in the case on the Royal Aircraft Factory and Mervin O'Gorman its civilian superintendent making a claim of £25,000. The claim was recognized by the Government, and the above named settlement was made, the reduced sum being accepted not to embarass the Government in the present time of stress. This recognition of the Wright patents will, of course, open the way for proceedings against other constructors of aeroplanes, who will undoubtedly make satisfactory arrangements without contest. While the above results will undoubtedly be agreeable to Orville Wright, a recognition of this character of the pioneer work of himself and his brother will mean far more than any money payment.

Wing Covering for Aeroplanes.—Many different materials have been tried for covering the wings of aeroplanes, including linen, silk, cotton, celluloid films and aluminium foil. To the lay mind silk would seem the best fitted for the purpose on account of its lightness and strength, but it has been found not to withstand exposure to sun and rain as well as could be desired, and it does not lend itself to the application of the dressing compounds that are intended to shrink the covering tautly over the frames, and render the fabric proof against the weather. As the result of experience it has been found that linen is the best material thus far used, for, after it has received several coats of a solution of casein, which is the substance generally used for the purpose, the fabric is found to be stretched as tightly as a drum head, making a very smooth surface, which is of great advantage in fast flights, and the coating also increases the strength of the linen and renders it more enduring under varying weather conditions. It is estimated that such a coating increases the strength of the linen at least 5 per cent, and the cost is small considering the advantages gained.

The Naval Fights in the Pacific and Indian Oceans

Superior Gun-Power Wins Decisively in the Recent Cruiser Engagements



Date, 1904. **Tonnage**, 3,250. **Speed**, 23 knots. **Guns:** Ten 4-inch. **Torpedo tubes**, two 17.7-inch.
I. Protected cruiser "Bremen."

Date, 1907. **Tonnage**, 11,600. **Speed**, 24.5 knots. **Belt**, 6-inch. **Guns:** Eight 8.2-inch, six 6-inch. **Torpedo tubes**, four 18-inch.
II. Armored cruiser "Gneisenau"; slightly damaged.

Date, 1907. **Tonnage**, 11,600. **Speed**, 22.5 knots. **Belt**, 6-inch. **Guns:** Eight 8.2-inch, six 6-inch. **Torpedo tubes**, four 18-inch.
III. Armored cruiser "Scharnhorst"; slightly damaged.

Date, 1908. **Tonnage**, 3,250. **Speed**, 23 knots. **Guns:** Ten 4-inch. **Torpedo tubes**, two 17.7-inch.
IV. Protected cruiser "Leipzig."

Date, 1908. **Tonnage**, 3,450. **Speed**, 24 knots. **Guns:** Ten 4-inch. **Torpedo tubes**, two 17.7-inch.
V. Protected cruiser "Nurnberg"; slightly damaged.

THE GERMAN SQUADRON WHICH WON THE FIGHT OFF CHILE

ALTHOUGH thus far in the great naval war there has been no clash between the major units of the several navies, that is, between the battleships and battle-cruisers upon which must depend the final issue, there has been frequent contact between the lesser units—the armored cruisers, protected cruisers, gunboats, scout-destroyers, and last, but by no means least, the submarines. Although these engagements and the losses resulting therefrom have not been of such a character as to vitally affect the ultimate issues of the war, they have been full of dramatic interest; and if they have taught no new lesson, they have at least served to emphasize the truth of certain principles which have come to be accepted as sound among naval men.

If it be admitted, as it must be, that the strategic success of the war as exemplified by the complete blockade of the German and Austrian fleets, and the sweeping of their commerce from the high seas, lies with the Allied fleets, it must in all fairness be admitted, *if we bear in mind the great preponderance of the British forces*, that the balance of the honors of the war in the engagements thus far fought rests upon the German fleet.

The most distinguished successes of the Germans, it goes without saying, are those which have been won by her submarine service; and we say this with full knowledge of the fact that since the British is the blockading force, its ships are more liable to submarine attacks than those of the Germans, who have been forced by necessity to remain within the shelter of the Baltic and their North Sea ports. The sinking of the armored cruisers "Aboukir," "Cressy," and "Hogue," and later of the protected cruiser "Hermes," has demonstrated that the Germans have developed a hitherto untried method of naval warfare to a high point of efficiency.

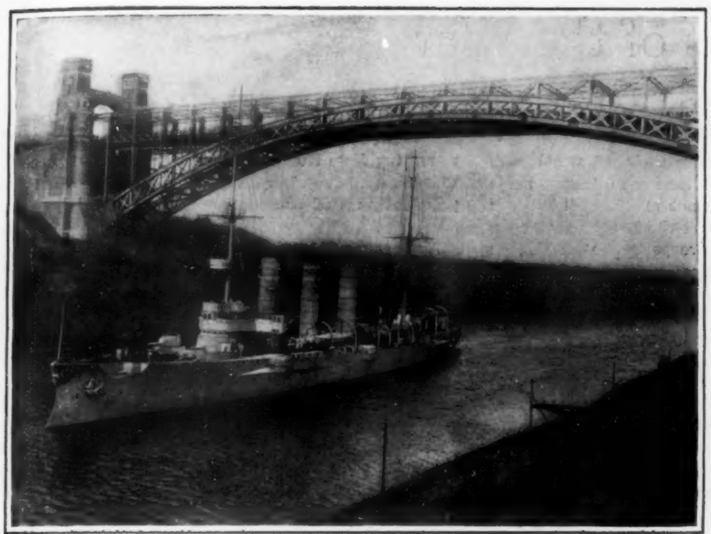
In the present article, however, we shall devote our attention to those engagements which have been fought out upon the surface of the water by that supreme weapon of attack, the gun—a type of weapon which, if we include its precursors the arrow, the javelin, and the bolt of the ancients, is as old as the history of naval warfare itself.

In the cruiser engagements which have taken place in the North Sea, and in the Pacific and Indian oceans, the outstanding fact is the decisive advantage which is held by the ship that carries the heavier battery. If we except the recent fight off the Chilean coast, these engagements have been fought, or mainly fought, between fast scout-cruisers and destroyers, carrying numerous batteries of the lighter guns, and in every case the ship mounting the larger gun, as was to be expected, succeeded in sinking or seriously crippling the enemy. Thus, in the fight off Heigoland, in which the opposing fleets, at least in the earlier phases of the engagement, consisted of scout-cruisers and destroyers, the British cruisers "Arethusa" and "Fearless," mounted 6-inch and 4-inch guns, and the German cruisers "Mainz," "Köln," and "Ariadne," mounted 4-inch guns. The official report stated that the "Arethusa," whose main battery consisted of 6-inch guns, contributed largely to the sinking of the German boats; although their final loss appears to have been due to their being drawn under the fire of the British battle-cruisers, when, of course, their destruction was inevitable.

Later, in the engagement off the Belgian coast, when four German destroyers were sunk by the "Undaunted," it was a case of the gun against the torpedo, and the 6-inch and 4-inch guns of the scout won out.

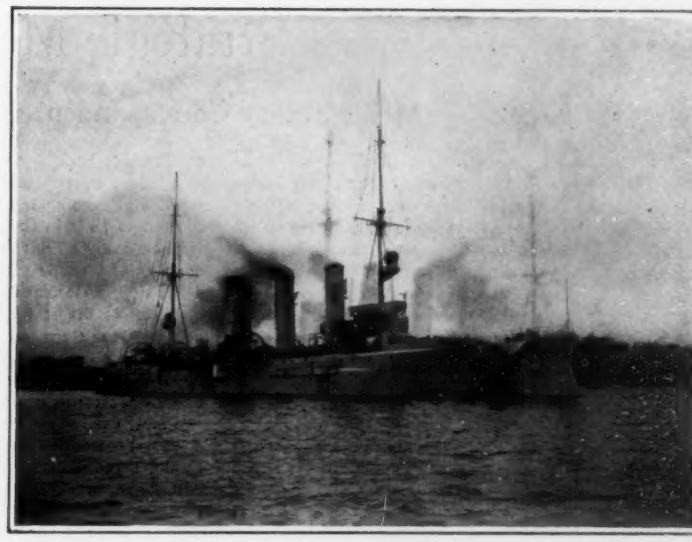
The most notable engagement of the war is that which was recently fought out off the Chilean coast, between two squadrons each composed of armored cruisers and protected cruisers. This was a gun fight pure and simple, and here again the heavier artillery won the day. On the German side were the two armored cruisers "Scharnhorst" and "Gneisenau," the scout-cruiser "Nurnberg," and the protected cruisers "Leipzig" and "Bremen," to which were opposed the British armored cruisers "Good Hope" and "Monmouth" and the protected cruiser "Glasgow." The action commenced apparently at about sundown, and continued for an hour or more until dark. Here, as in the actions in the North Sea, superiority in number of ships and weight of armament lay with the victorious fleet and the "Good Hope" was silenced, set on fire and sunk, the "Monmouth" being also crippled and set on fire, and, so far as the latest dispatches inform us, was either sunk or beached on the Chilean coast. The "Glasgow" escaped, and with the converted collier "Otranto" was later reported passing through the Straits of Magellan and making for the nearest British port. The armored cruisers "Scharnhorst" and "Gneisenau" and the scout-cruiser "Nurnberg" put into Valparaiso, and according to German reports had received little damage. The "Leipzig" and "Bremen" later reported at Valparaiso.

The interest of this fight centers in the armored cruisers. On the British side were the "Good Hope" of 14,000 tons, mounting two 9.2-inch guns and sixteen 6-inch, and the "Monmouth," mounting fourteen 6-inch guns. Against them the German armored cruisers could oppose sixteen 8.-2-inch guns and twelve 6-inch guns. The two German ships were protected by 6 inches of armor; the "Good Hope" carried 6 inches of armor on her belt and the "Monmouth" 4 inches. The engagement was fought out in line ahead, with the ships steaming before a heavy head sea on parallel or slightly converging courses. A comparison of the respective broadsides shows that the British could oppose two 9.2-inch armor-piercing guns and seventeen 6-inch guns against twelve 8.2-inch, armor-piercing guns, and twelve 6-inch guns. The ships were running before a heavy northerly gale, and hence probably all of them were rolling heavily. So it is not surprising that the first salvo, delivered, according to some of the earlier reports, at eight or nine thousand yards, fell short. The first



Date, 1908. **Tonnage,** 3,600. **Speed,** 25 knots. **Guns:** Ten 4-inch. **Torpedo tubes,** two 17.7 inch.

The scout-cruiser "Emden," destroyed by the Australian scout-cruiser "Sydney." Her remarkable cruise in the Indian Ocean, where she sank the "Jemtchug" and a destroyer and captured or destroyed some 25 or 30 vessels, takes rank with the exploits of the "Alabama" during our civil war.



Date, 1907. **Tonnage,** 3,400. **Speed,** 23.5 knots. **Guns:** Ten 4-inch. **Torpedo tubes,** two 17.7-inch.

The protected cruiser "Koenigsberg," which, during her cruise off the east coast of Africa, destroyed the "Pegasus" (repairing in Zanzibar harbor), and has now been blocked in and shelled by the "Chatham" on the German East African coast.

effective broadside seems to have been got home by the German cruisers at 6,000 yards, and, as the ships were on slightly converging courses, the damage to the British seems to have been done between this range and the range of 4,500 yards, at which the action ceased, darkness then coming on.

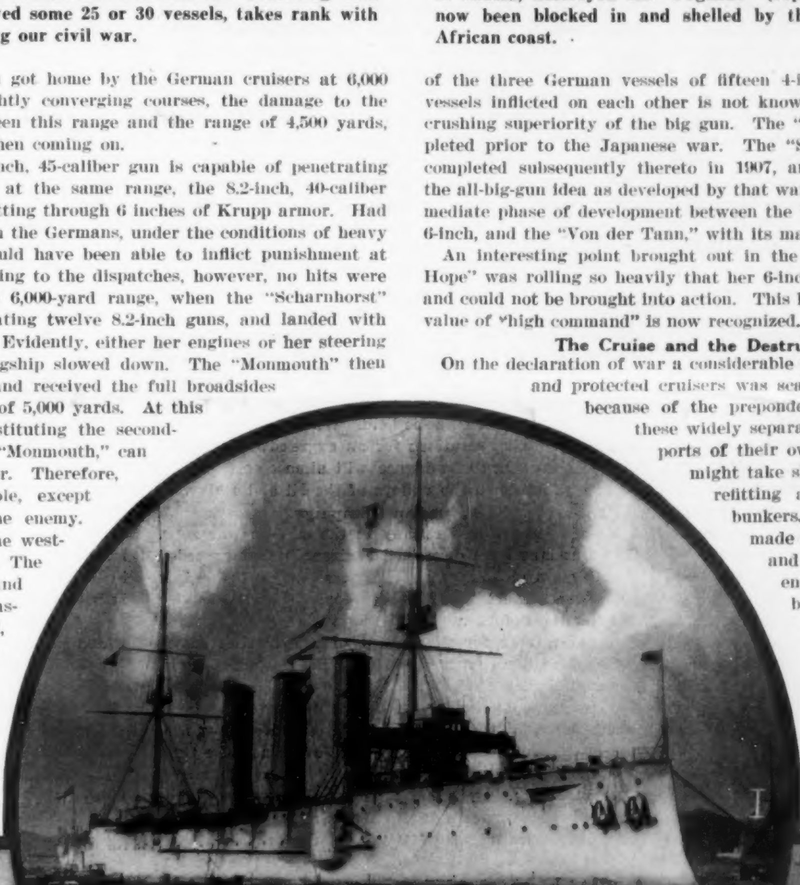
Now at 6,000 yards the British 9.2-inch, 45-caliber gun is capable of penetrating about 8½ inches of Krupp steel, and at the same range, the 8.2-inch, 40-caliber German gun is capable of just about getting through 6 inches of Krupp armor. Had the British gunners been able to land on the Germans, under the conditions of heavy roll existing at the time, the 9.2's should have been able to inflict punishment at seven or eight thousand yards. According to the dispatches, however, no hits were made until the ships were within the 6,000-yard range, when the "Scharnhorst" and "Gneisenau" let go salvos, aggregating twelve 8.2-inch guns, and landed with crushing effect upon the "Good Hope." Evidently, either her engines or her steering gear were crippled, and the British flagship slowed down. The "Monmouth" then moved up to cover the "Good Hope," and received the full broadsides of the Germans' heavy guns at ranges of 5,000 yards. At this range the 45-caliber, 6-inch guns, constituting the secondary batteries of the "Good Hope" and "Monmouth," can penetrate only 3 inches of Krupp armor. Therefore, their 6-inch batteries were unavailable, except against the unarmored portions of the enemy. The "Good Hope," on fire, turned to the westward, and apparently blew up and sank. The "Monmouth," on fire, disappeared, and either sank, or was beached. The "Glasgow" of 4,800 tons and 26½ knots speed, is a cruiser built in 1911. She mounts two 6-inch and ten 4-inch guns. She was apparently mainly engaged with the three German protected cruisers, which, like herself, were unarmored vessels. She could oppose a broadside of two 6-inch and five 4-inch guns against the united broadside of the three German vessels of fifteen 4-inch guns. What damage these lighter vessels inflicted on each other is not known. The fight establishes once more the crushing superiority of the big gun. The "Drake" and the "Monmouth" were completed prior to the Japanese war. The "Scharnhorst" and the "Gneisenau" were completed subsequently thereto in 1907, and they seem to show the influence of the all-big-gun idea as developed by that war. The "Scharnhorst" indicates an intermediate phase of development between the "Yorck," mounting four 8.2-inch and ten 6-inch, and the "Von der Tann," with its main battery of eight 11-inch guns.

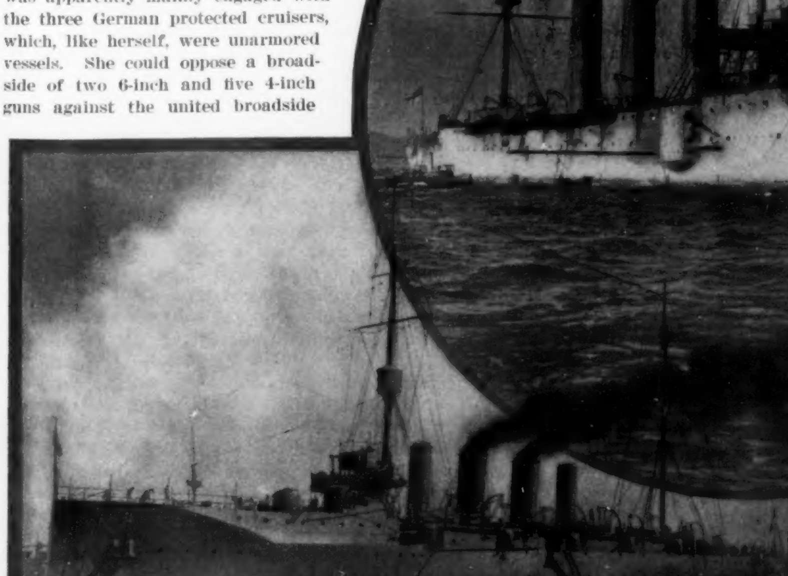
An interesting point brought out in the dispatches, is the fact that the "Good Hope" was rolling so heavily that her 6-inch battery on the berth deck was awash and could not be brought into action. This has been remedied in later ships, and the value of "high command" is now recognized.

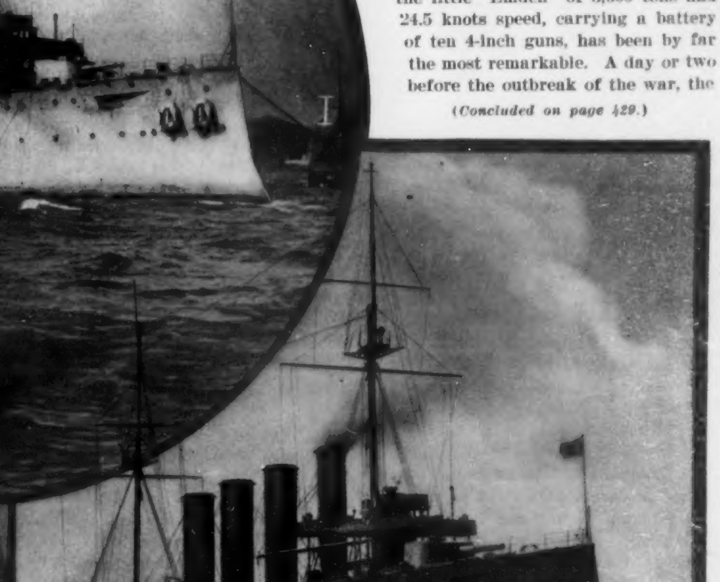
The Cruise and the Destruction of the "Emden."

On the declaration of war a considerable portion of Germany's fleet of fast scouts and protected cruisers was scattered widely over the seven seas; and because of the preponderance of strength of the allied fleets, these widely separated units found themselves without any ports of their own or any friendly bases in which they might take shelter or to which they could repair for refitting and replenishment of stores and coal bunkers. Under the circumstances these ships made for the various lines of steamship travel, and proceeded to work such damage to the enemy's commerce as they might be able, before the ultimate and inevitable day of their capture or destruction arrived. Of the work of these commerce destroyers, for such they now became, that of the little "Emden" of 3,600 tons and 24.5 knots speed, carrying a battery of ten 4-inch guns, has been by far the most remarkable. A day or two before the outbreak of the war, the

(Concluded on page 429.)







Date, 1903. **Tonnage,** 9,800. **Speed,** 23.5 knots. **Belt,** 4-inch. **Guns:** Fourteen 6-inch. **Torpedo tubes,** two 18-inch.

I. Armored cruiser "Monmouth"; put out of action by gun fire.

Date, 1911. **Tonnage,** 4,800. **Speed,** 26.5 knots. **Guns:** Two 6-inch, ten 4-inch. **Torpedo tubes,** two 18-inch.

II. Scout-cruiser "Glasgow"; escaped; reported at Magellan.

Date, 1902. **Tonnage,** 14,000. **Speed,** 23.5 knots. **Guns:** Two 9.2-inch, sixteen 6-inch. **Torpedo tubes,** two 18-inch.

III. Armored cruiser "Good Hope"; sunk by gun fire.

THE BRITISH SQUADRON WHICH WAS OVERWHELMED IN THE CHILEAN FIGHT

Strategic Moves of the War

Letter from the Military Correspondent of the Scientific American, November 14th, 1914

The Campaign in France.

THE week has seen a continuation of the deadlock in the fighting in France. This close-quarter fighting between determined combatants is especially trying on the *morale* and results in large losses without apparent gains in position. At all important points the lines have been pushed forward by dashes by night until the contending forces are within only a few hundred yards of each other. Here they burrow for protection against the intermittent storms of shrapnel and here they wait on guard either to repel possible attacks by the enemy or to muster strength for another surprise move to the front.

Sometimes these sallies catch the opponents off their guard sufficiently to drive out of their front trenches the troops that are left there as a garrison. The enemy then retains their trench lines in rear and rush forward reserves from the sheltered points in rear where they have been maintained for just such an emergency. The attacking force is checked along the second line of trenches or even along the third line, and both sets of combatants then proceed to modify their new positions so as to give the needed protection for firing trenches and also to construct the usual reserve lines of trenches in rear.

The above maneuver has occurred again and again during the recent fighting along the long battle line in France and Belgium. Each side heralds its advance as a notable success and omits mention of its reverses. The actual status of the fighting is, on the whole, an even exchange of minor successes, with no change in the general positions.

The German campaign has been less aggressive since the capture of Antwerp, because of their effort to strike a telling blow at Russia. While they were diverting a large part of their strength to Russia, they were well content with an even break in France. The failure of their campaign in Poland was, then, a serious blow to their strategic plan of operations.

The Allies in the western theater of the war are also well satisfied to hold even for the present. They have a superiority of numbers, but require time to provide the guns, ammunition, and other supplies that are needed to fully equip such immense numbers.

While they were unable to complete their preparation before the war broke out, they now have the advantage of the resources of the whole world to draw on for military supplies. The Germans and Austrians are, on the other hand, limited to home production or to supplies accumulated before the outbreak of the war. In food supplies, clothing, and iron these countries should have little trouble in making good the waste of war, but in some minor items they will soon be confronted with a shortage.

One of the important developments of the war has been the efficient service of automobile transport in moving supplies, guns, and troops. Germany had apparently accumulated immense stores of spirits and gasoline at the outbreak of war, but it seems questionable whether any stock could long supply the enormous requirements of the many thousand automobiles that are now in service. Germany's supply of gasoline and petroleum derivatives comes from three sources: Galicia, Caucasia, and America. All are now shut off from the German market. The large supply of alcohol normally obtained from grains and potatoes must now be largely reduced, due to the need of using these food products for subsistence. Even if Germany and Austria are able to maintain their thousands of automobiles in usable condition, they are likely to find this service handicapped by shortage of fuel.

The copper shortage is especially important because copper bands are necessary for the projectiles. Copper is also used for cartridge cases and for many important gun fittings. The most serious deficiencies that are likely to develop are those in nitric acid and in camphor. Both of these are essential for the manufacture of powder and both are obtained by Germany almost entirely from imported materials. While the supply of trained soldiers may make possible a war of several years' duration, it seems probable that the exhaustion of military supplies may weaken the German strength before the expiration of eighteen months. Whatever the outcome may be, it seems improbable that the war will be decided before the end of next summer.

The only two concerted moves toward definite ends in the attacks and counter-attacks of the fighting in France are on the two flanks.

In Belgium the Germans gave up their attempt to force a way across the Yser River between Dixmude and the coast, due to the impossibility of moving artillery in the inundated districts. Farther south, though, in the vicinity of Ypres they have driven the French and British back five miles from their advanced position near Roulers. At the same time the Germans made spirited attacks against the French and British between Arras and Lille in the hope that the latter might have weakened their lines to send troops to the fighting on the flank. This latter fighting is probably the main effort of the Germans, the other fighting being demonstrations to divert the Allies' troops from the critical point. If the Germans can break through at Arras they will be on the short line to the coast. This is directly opposite their main line of communications *via* Namur and Liège; consequently to this part of the front they can most easily rush the large force needed for the successful prosecution of such a move. If the Germans should succeed in this attempt they would cut off the Allies' armies from Arras to the coast and might be able to capture a large part of their isolated forces. This is why the French and British are making such strenuous efforts to hold this part of their line. They cannot retreat from Arras without involving all of their left flank.

In the Woevre region, southeast of Verdun, the French have been unable to overcome the fire of the German heavy artillery. They have, however, maintained their positions on both flanks of the German salient at St. Mihiel. The fighting power of the Germans is especially noteworthy in thus maintaining their hold on the Meuse River in spite of being surrounded on three sides by superior numbers.

On both the Lorraine and the Alsace borders the developments of the week were peculiarly gratifying to the French, though they have as yet little influence on the general military situation. North of Nancy the French have advanced to the Seille River and the German boundary, occupying Nomeny, Champenoux, and Badonviller. From St. Die southward the French hold the summits of the Vosges Mountains, while in Upper Alsace they have captured Thann and Altkirch, eight miles east of the border. This move is as yet only a local success, due to the weak force with which this flank of the German line is held. When the Allies have completed their operations for an aggressive campaign, one of their lines of advance will almost certainly be from Belfort down the valleys of the Ill and Rhine.

The Russian Campaign.

Events have moved rapidly in the eastern war zone. The Russians have developed a strength that exceeded the German and Austrian estimates and that bids fair to influence the whole war situation.

After the defeat west of Warsaw the Germans made a rapid retreat for fifty miles to the Warthe River, which here flows from south to north and parallels the German border. When the Russians reached this line the Germans again fell back to the entrenched line along the ridge between Kalisz and Czenstochowa that forms the watershed between the Warthe and the Oder rivers. Here they had carefully prepared a strong defensive line. By this rapid strategic retreat they secured the advantage of picking up their various garrison detachments and of regaining contact with their railway service, with the consequent facilities for forwarding reinforcements and supplies.

The Germans hoped that the Russians would press forward against this line. The latter would necessarily have to leave their heavy artillery behind and would have their strength cut down by the unavoidable losses of a rapid pursuit. Instead, the Russians slowed up their frontal attack and pushed forward a large army of Cossack divisions that, advancing *via* Kutno and Kolo, on the Warthe, have reached a point near Pleschen, fifteen miles northwest of Kalisz, where they threaten the German supply lines. If this force is strong enough to continue its threatening raid, the Germans will have no choice but to abandon their strong position between Kalisz and Czenstochowa.

This defeat of the German army in Poland has likewise affected the developments in the other fields of fighting. The East Prussian army has been called on to furnish guards for the Posen border. Consequently it has had to fall back to positions where its reduced strength would have better chance to withstand the Russians. The latter have pressed forward vigorously and have captured Lyck, Margrabowa, and Goldapp, ten miles west of the border. This retreat can be expected to continue, as the Germans have insufficient total strength to spare the force that would be required to maintain an advanced position in East Prussia.

Near Mlawa, where the railroad from Warsaw to Koenigsberg crosses the border, the Russians have also driven the Germans out of Poland. Along the Vistula the latter have retreated from Wloclawek to Nieschawa, half way to the border, while farther south, on the Warthe, they have again been driven back to the border, retreating from Konin to Slupza. The initial success at Warsaw and its vigorous prosecution have then freed practically all of Russian territory from German occupation.

Against the Austrians the Russians have had equal success, though the former still retain possession of a small strip of Russian territory. The defeat of the German left caused them to call in their troops from the south. The Austrians were thus left unsupported and were forced to fall back rapidly from their position along the Vistula. Their first stand was made at Radom and Opatow, then next just north of Kielce. The retreat from this position in turn exposed the Austrian army along the San and forced it to keep pace in retiring. The Russian pursuit has pressed closely behind and has now carried them to Miechow, only twenty miles from Cracow.

The Russian advance in southwest Poland so threatened the rear of the Austrian army at Przemysl that it was forced to give way. The principal line of retreat of the latter is south of Cracow *via* the open pass leading into Moravia; so the Russian advance to Miechow threatens to interpose their army between the Austrian Galician army and their natural line of retreat. The latter, consequently, have had to abandon all of central Galicia to the Russians in order to save their army from disaster. By retreating to the west they steadily augment the strength of their forces in front of Cracow and correspondingly increase their chances of checking the Russian advance in this quarter.

This Austrian retreat has already enabled the Russians to advance to Rzeszow and Lisko, thirty miles west of Przemysl. Within a few days they will probably have regained the lines at Tarnow which they abandoned when the Germans made their great advance in the first week of October.

The Turkish Campaign.

The advent of Turkey into the war has had little immediate effect upon the situation, as both Russia and Great Britain had taken steps to protect their interests against this eventuality. Russia has retained her three Caucasian army corps in their peace locations on the southern border and Great Britain has concentrated a large garrison to protect the Isthmus of Suez.

Turkey has, on paper, an army of thirteen army corps, about 500,000 men. She must, however, keep a large force in Europe and the adjacent Asiatic provinces in view of the unsettled attitude of the Balkan States. It is hardly likely that she has more than 90,000 men to send against the Suez Canal, or more than 60,000 with which to oppose the Russian invasion of Armenia.

The British operations have so far been directed against Akaba, where the Turkish army is concentrating. The new Syrian railway leading southward from Damascus in this move shows its strategic value to the Ottoman Empire. Due to this supply route, she can now concentrate and maintain in this desert region many times the force that would otherwise be possible. For the defense of the canal, the British have 15,000 Australasians, besides British Territorials and many regiments from India. The British contingent from Kiaochow will also soon be available.

The Russian campaign against Turkey has consisted of an invasion of Armenia by an army of about 90,000 men from Batun, Kars, and Erivan in Caucasia. This army has now advanced twenty-five miles, half way to Erzerum, through a rugged country, devoid of good roads, that lends itself to defensive fighting. The Russian progress will, accordingly, be slow, but should result, in a few weeks, in the complete occupation of the border provinces of Trebizond and Erzerum. The Russians will hardly advance much beyond this unless they more than double the force now operating in this region.

Mention has been made in dispatches of an advance by this route to Constantinople. Such a move would require 400,000 men and three months time. Long before this period elapses the command of the Black Sea will have been settled and Russia will be able to transport troops direct to the point that may be seized as a base for operations against the Turkish capital.

Scientific Journals and the European War

IN the SCIENTIFIC AMERICAN of October 17th we published a note to the effect that there was a dearth of foreign scientific journals owing to the European war. Several of our readers have called our attention to the fact that such a dearth no longer exists. As a matter of fact, while the note in question was still on the press, copies of foreign periodicals, particularly German journals, were coming into the office of the SCIENTIFIC AMERICAN. They are now received with considerable regularity, although necessarily somewhat delayed.

Letters from the Firing Line

The War in the Sky

By Aide-de-Camp Xavier Sager, Special Correspondent of the Scientific American at the Front

WHILE the public is particularly impressed by the exploits of the aerial battalions now engaging in war for the first time, it is important to state that in this enormous conflict of millions of men the few hundreds of aeroplanes and the few dozens of dirigibles which mingle in the fight, rarely play the part of the offensive. Outside of its given mission of fighting the sky battalion of the enemy far above the densely massed army, and dropping bombs on their hangars, the aerial offensive would be of little value in the conduct of the war. The aeroplanes and dirigibles would not be sufficient in themselves to destroy an army corps, but by means of them its movements are observed. The aeroplane in war is the eye of the army in the sky.

For reconnoitering the aeroplane is an excellent instrument on account of the tremendous spread of modern armies and the enormous length of the battle front. It must not be thought, however (as was thought at the beginning of the war) that its powers of observation are unlimited. Indeed, it is very difficult for an aviator who is flying at a great height to report the position of troops, to describe them and to estimate their number, especially as the enemy hides a part of his troops in the woods and masks his guns. The aeroplane does not pretend entirely to replace the cavalry scout. The latter will always be necessary to discern the physical and moral condition of the adversary.

In regard to the destruction of the aerial flotilla of the enemy, it seems that the aeroplane is particularly efficient against the dirigible because of its superior speed and its greater facility in maneuvering. For instance, the aeroplane will be able by flying over the dirigible to attack it with incendiary projectiles. A fight between two aeroplanes is more difficult and will, in most instances, prove fatal to one of the two adversaries. If either one wishes to avoid a combat his fate depends upon the speed of his machine, but it must be remembered that the aeroplane which is flying away is an excellent target for the pursuer.

So far it does not appear that we can expect very great results from the throwing of projectiles upon troops or fortifications or magazines. Recent experiences show the impossibility of securing exact aim. Dirigibles which fly at a lower level than aeroplanes and carry explosives of greater weight (ten magazines of ammunition) are assuredly more formidable. On the other hand, their volume and their relatively slow flight permit the adversary to fire at them with greater accuracy. It is very difficult for the soldiers on land to hit an aeroplane. Even the special guns which have been constructed for this purpose cannot be used with much accuracy when the target is flying above an elevation of a thousand meters.

The Germans have worked out some very skillful curves (I have just been studying them), which would seem to indicate that accurate training of guns at an aeroplane in flight is a problem easier to solve in theory than in practice. An aeroplane covering 120 kilometers (75 miles) per hour, flying very high and describing irregular curves in an atmosphere where the refraction of light produces curious visual errors, is a target as difficult to hit as a swallow in flight. There is, it is true, a shell designed to burn while in flight, leaving a trail of black smoke to indicate its trajectory, but by the time the gunner has corrected his aim, the aviator has sped far off.

Above the long lines of the actual battles, an aviator in quest of general information has no time to lose. All his mental faculties are at work: the position of the enemy, its number, how its troops are laid out—all this he must grasp at a glimpse, always prompt to avoid a shot, always ready to defend himself against any unexpected attack from the air or from the land. Helped by the information that the daring aviator has brought, the batteries start their fire, and the shrapnel does not go astray. In certain instances the aeroplanes have rendered valuable services to the cavalry.

It seems that up to the present moment the German aviators have not been as lucky as the French in their work of general aeroplane scouting; but they have shown great bravery and tenacity in the smaller reconnoiterings of the army. They come, they go, they glide, they turn, they come back in such a way that our troops exclaim: "One sees nothing but German aircraft," and they believe, quite wrongly, that the French aviator does not exist. They are mistaken. Nine times out of ten a Taube will draw back before our *avions*. If one of their "pigeons," venturing above the French lines, perceives one of our "corsaires," it flies back in great haste to its nest.

Lately, I witnessed the magnificent spectacle of a duel which took place 1,500 meters above us between two biplanes, one a French Voisin and the other a German Aviatik. At 8 o'clock in the morning the German biplane appeared, very easy to recognize on account of the great white crosses under the wings. At 9 o'clock the Aviatik passes again over our encampment, it is going back toward the German lines. Five minutes later a Voisin biplane, coming from the German lines, appears in the skies, first like a dot, and gradually becoming more and more discernible. We take our field glasses. We can plainly hear the noise of the two motors, and now the field glasses are unnecessary for we can follow the fight with the naked eye. The German biplane, in order to avoid the French had descended a few hundred meters. It is now flying at a height of about 1,200 meters. The French pilot rushes straight upon the German, keeping his machine higher than the enemy's. A few shots are fired from the French machine gun on board the Voisin. The German passes under the French aeroplane, trying to regain the shelter of his lines; it flies toward the north. The French, maintaining its elevation, turns on itself, describing a circle of a very small radius. It pursues the Aviatik, it comes nearer and nearer to it, it flies over it, it is ahead of it; then it turns, and coming back upon the German, it fires a few shots. In its precipitate flight from the French biplane the Aviatik describes many circles in the air. But the fight is on now; they have come together, and from both biplanes shots are fired. The German defends himself bravely. The two machines maneuver continually in the air, sometimes rearing like horses. The German loses some height, tries to regain it, and seems to be flying again toward the north, but suddenly it describes a short circuit and flies back upon the French biplane. The French machine gun fires repeatedly, the Aviatik pitches three times, sinks head first, and describes a spiral descent. The victorious biplane circles above the falling Aviatik, descending slowly over it, like a vulture over its prey. The Aviatik pitches to the ground a few hundred meters from us and we run to the spot. It has fallen in the swampy land near a large pond. The ground is so soft that our feet sink in to the ankles. The motor is almost entirely buried in the ground; the frame is twisted; the wings are shattered to pieces. One of the aviators, the pilot, has been killed; his body lies ten feet away. The second aviator has been caught under the motor, which is burning. It is red hot. We are helpless to give him assistance. He seems to try to untangle himself, but it is only a last convulsion; he looks at us; he clutches at the earth with his hands, and dies.

After the German biplane had stopped burning we came nearer. The motor was the only thing left, and we found a bomb which, fortunately, had not exploded.

The fight between two aeroplanes is merciless. One of the two must perish. The aviators know it, and still they are eager to fight.

Are the Zeppelins to be feared? The Germans at the beginning of this war had placed great confidence in the activity of their dirigibles. Are they a grave menace to the security of the French and British armies? This has seriously been considered by our *etat major*. Some schemes have been evolved, and many pieces of light artillery have been placed at strategic points, with the purpose of destroying the Zeppelins should they attempt a raid.

Concerning the efficiency of the Zeppelins, we have the official investigation made by competent authorities at Luneville, at the time that the "Zeppelin IV" landed there. From the speed entered in the log-book of the dirigible and after examination of the diagram of its flight, it appeared that the maximum speed attained was only 72 kilometers (45 miles).

Furthermore, the log-book referred to a load of 4,800 kilogrammes (10,582 pounds) for an ascensional force of 20,500 kilogrammes (45,194 pounds), that is, a proportion of 24 per cent, which is exceedingly small. The consumption of fuel was 135 kilogrammes (298 pounds) per hour. The supply was 950 kilogrammes (2,094 pounds), enough for a trip of seven or eight hours. To attain the height of 1,900 meters (6,234 feet) indicated in the diagram of its route, the Zeppelin had been obliged to throw off 3,000 kilogrammes (6,614 pounds) of ballast. As the equipment weighed 950 kilogrammes (2,094 pounds), the total weight was 4,900 kilogrammes (10,802 pounds). This is equal, and even exceeds somewhat the figure given; and this without guns, without armament, without ammunition. It is safe to say that a Zeppelin having to travel under military conditions—that is to say, in high altitude and with its war equipment—can carry a supply of fuel and oil which will last him not more than ten hours; and in case of head winds, even of the slightest, it will not cover a distance greater than 550 kilometers (341 miles).*

Suppose that a Zeppelin, starting from Metz, were flying toward Paris, the distance it would have to cover would be 800 kilometers (497 miles). During this trip it could not rise higher than 1,000 or 1,200 meters, which is not a sufficient height to protect it from the fire of our artillery. And then, the invulnerability of a Zeppelin is far from being what has been represented.

The bombs carried by the Zeppelins measure 1 meter and 20 centimeters (47 inches) in length and are 20 centimeters (8 inches) in diameter. Their weight varies between 100 and 110 kilogrammes (220 to 242 pounds). They are loaded with picric acid.

Bombs used by aeroplanes are exploded by the shock of impact with the earth or any hard matter. They are loaded with round balls. Their explosion is accompanied by a cloud of dense black smoke, acrid of smell; the same smoke that accompanies the explosion of certain German shells. These bombs are mounted like arrows and have a triangular arrow shaft or feather of steel. Practically the whole weight is in the head or body, so that the bomb will fall like a rocket and strike perpendicularly. The system of aiming is simple. While the aviator is in flight the bombs are suspended by a light thread, and the observer, on determining the point he wishes to strike, detaches the bomb without touching it, simply by cutting the thread.

When the vertical rudder of the aeroplane lies straight in the axis of the machine, the aviator aims, with an indicator affixed to the fuselage. This indicator is a small ring with a metal finger. When this is in line with the target the bomb will reach its mark.

The firing of guns is a thing almost impossible, the speed of the aeroplane being not always uniform and the wind being variable. The deviation of an aeroplane bomb, notwithstanding its weight (20 kilogrammes or 44 pounds) and the rapidity of its fall, may vary greatly. It is for this reason that the point aimed at is not generally reached, especially where the machine is flying at a high altitude.

* It will be noted that these data relating to the Zeppelins differ from those which we have published in the Scientific American.

The Current Supplement

A VALUABLE feature of the current Supplement, of the Scientific American, No. 2029, for November 21st, is a very comprehensive article on The Care of the Wounded, which contains much interesting information on this important, but little understood, branch of an army in the field. It tells about the organization of ambulance and hospital corps, how the injured are found, treated and conveyed to the various hospital stations; the first aid packets carried by all soldiers in modern armies, and a description of the use of dogs by the Red Cross workers, together with numerous illustrations of these features and of a military hospital train. A comparatively new idea in aero work is the use of adjustable wings and a variable speed motor, and this is the subject of an article by an expert which will be appreciated by all interested in aeronautics. There is also a report of some new experiments on aeroplane problems by M. Eiffel, the celebrated French authority. The article on the design of floats for hydro-aeroplanes is concluded. In the article on muscular activity and thought processes, the writer reviews the various psychological theories that have prevailed, and makes an interesting addition thereto. The description, with illustrations, of a home-made electrical incubator and brooder, which most anyone can make, will delight every amateur chicken fancier. Other articles describe devices for regulating the flow of effluents or streams; a slow-speed electric motor; measurements of textile fibers, and information about fuel alcohols.

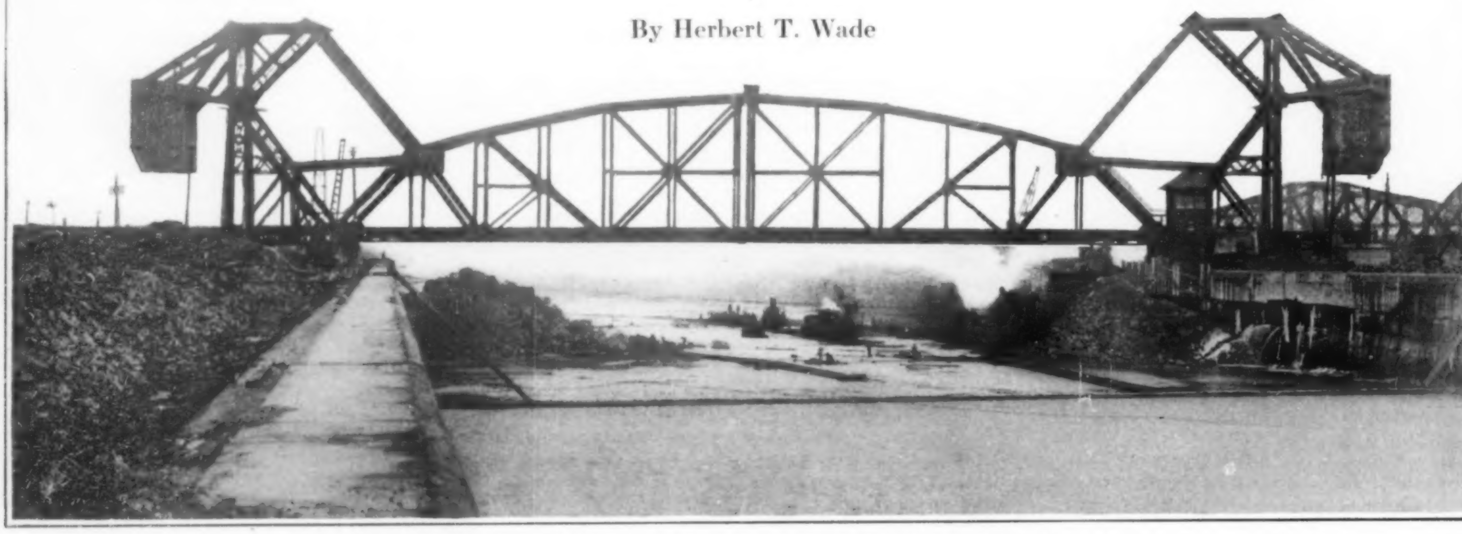
Prize for a Stump Puller

THE Craddock Agricultural Society of Cape Colony, South Africa, has offered a prize of £15 ($76.65) for the best, cheapest, and most effective means of pulling stumps ("stubbing," as they term it). The test will be held at the 1915 Show, and entries must be made by February 10th, 1915. Application forms can be had from the Bureau of Foreign and Domestic Commerce, Washington, D. C.

The World's Longest Bascule Bridge

How Two Folding Leaves of Huge Dimensions are Made to Form a Single Rigid Span

By Herbert T. Wade

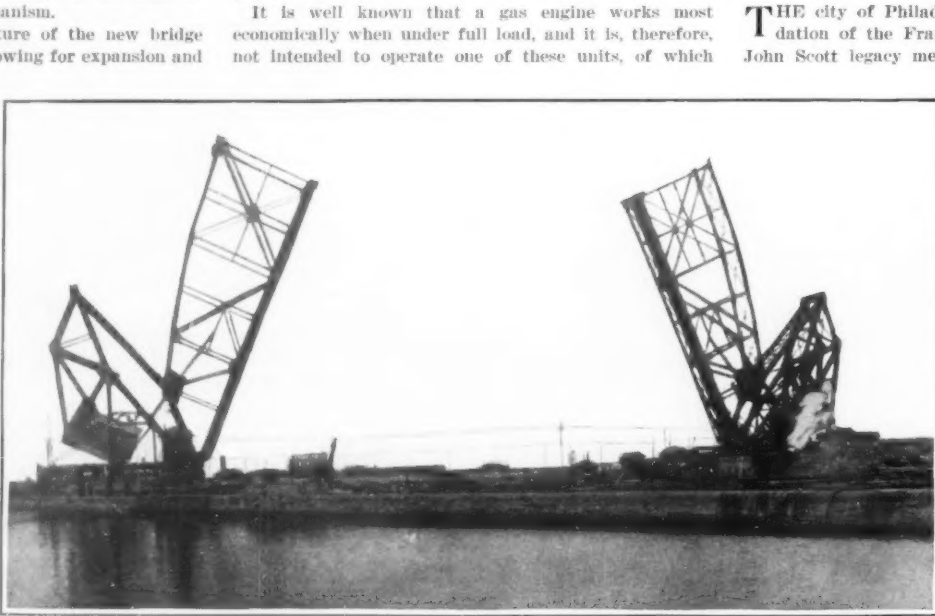


When the bridge is closed the leaves interlock and act as a simple span from pier to pier.

THE longest bascule bridge in the world, crossing the United States ship canal at Sault Ste. Marie, Michigan, now has been in successful operation for several months, and aside from its record size, it presents many interesting and novel points in design. It is 356 feet in length between centers of front piers, or 336 feet from trunnion to trunnion, and has two folding leaves, which, as shown in the illustration, interlock in such a manner as to form a single rigid span from pier to pier. This is the first time that this feature of bascule bridge construction has ever been accomplished, and naturally increases the length of span across which such a bridge may be used. The Sault Ste. Marie bridge has its leaves of the Strauss heel-trunnion type, each leaf being formed of two riveted trusses 168 feet in length and 55 feet deep, spaced 20 feet apart on the centers. They carry a single track for the Canadian Pacific Railway, forming a portion of the International bridge across the St. Mary's River. The leaves are counterbalanced by heavy, overhead masses of concrete, which are suspended from counterweight trusses connected to the bascule trusses by parallel links. Each leaf with its mechanism is carried on a tower, the trunnion being located at the base of the framing carrying the bearing for the counterweight and counterweight mechanism.

The specially interesting feature of the new bridge is the arrangement made for allowing for expansion and contraction at one end of the span. This is accomplished by placing one entire tower with its leaf and counterweight on rollers, so that this end of the span is free to move when the bridge is closed, but when the opening mechanism is in operation the tower may be held stationary. When the bridge is lowered the bottom chords unite somewhat in the same fashion of an ordinary car coupling at a tension hinge which can be locked so that the two leaves are joined together, and under a live load act as a single span from pier to pier.

The bridge is operated from one operator's house by electricity, and may be opened and closed in 1¼ minutes. A hydraulic control with an oil pump enables the operator to adjust the position of the tower according to temperature. When it is realized that the superstructure is 426 feet long over all, including towers, the amount of contraction and expansion which must be allowed for can be readily appreciated. The entire structure contains about 1,400 tons of structural steel, and each bascule leaf with its floor system weighs about 400 tons. While the bascule bridge long has ceased to be a novelty, yet the features incorporated in the present structure are so unique as to have aroused considerable attention. The system of top and bottom chord locks at the center of the span provide for compression, tension, and shear, and have been so carefully arranged that a strong and homogeneous structure has been secured.



Bascule bridge across the United States ship canal at Sault Ste. Marie with leaves folded.

Economical Power

ALTHOUGH the economical generation of power has for many years been a theoretical proposition well understood among engineers, there are still too many plants where either the fear of "complication," or a lack of understanding of what can be easily accomplished, is keeping decidedly wasteful power plants in operation. In contrast with such is the equipment of the Ford Motor Company, at their new Detroit shops, which is probably the most elaborate and complete combination of economic methods and apparatus that has been installed in this country, and is a most interesting example of systematic utilization of practically the entire heat value. This outfit consists of units of a two-cylinder gas engine, arranged in tandem, and a tandem compound condensing steam engine, both connected to the same shaft, and capable of developing 6,000 horsepower.

It is well known that a gas engine works most economically when under full load, and it is, therefore, not intended to operate one of these units, of which there are four, unless there is at least half a load for it. Then the steam side of the unit will handle the extra load, which enables it to do all the regulating, it alone being provided with a governor, and no provision for governing is provided for the gas side. The steam exhaust is connected with a surface condenser, in which the vacuum is regulated according to the atmospheric temperature, and the warm circulating water from the condenser is passed through the heating system in the adjoining buildings. The exhaust from the gas engine side goes to a superheater located in the steam line between the high and low pressure steam cylinders, thus utilizing a portion of its heat to regenerate the steam before it reaches the low pressure cylinder. Another portion of the hot gases of the gas engine exhaust is passed through the jacket of the high pressure steam cylinder to prevent heat losses here, instead of using direct steam from the boiler, as is customary. All of the exhaust gases are then led to a feed water heater, through which all the water required for steam purposes passes. This feed water is first circulated through the jackets of the gas engine cylinders, where it reaches a temperature of from 150 degrees to 180 degrees, and in passing through the heater the water is raised to 250 degrees. It will be seen that for all practical purposes all of the heat generated is utilized, and the economy of the plant should be marked.

The gas engine side is of the four-stroke system, with cylinders 42 inches in diameter and 72-inch stroke, while the steam cylinders are 36 and 68 inches diameter and 72-inch stroke.

Award of the John Scott Medal

THE city of Philadelphia, acting on the recommendation of the Franklin Institute, has awarded the John Scott legacy medal and premium to Elmer Ambrose Sperry of New York, N. Y., for his gyro compass.

On battleships under action, the shifting of large masses of magnetic material precludes the use of the magnetic compass, and even in an ordinary iron vessel, the material of the ship and its disposition must be compensated for. The gyro compass is entirely non-magnetic and is unaffected by the proximity of iron.

For some years Mr. Sperry has devoted practically his whole time to overcoming the numerous physical difficulties involved in the adaptation of a gyroscope to a ship's compass in the place of a magnetic needle. He has been able to make an instrument which automatically corrects for the speed and direction of the vessel, and which is unaffected by the rolling of the ship in a heavy sea. His compass may be made in the form of a master compass which may be made to actuate secondary or repeater compasses mounted in any desired part of the vessel. On naval vessels such an arrangement is very desirable, as the master compass may be installed behind heavy armor plate and protected from damage, and may still be available when all the secondary compasses are destroyed.

Wirelessly-Controlled Beacons

A New Use for Hertzian Waves

By Major H. Bannerman-Phillips

IT has been found necessary for the safety of ships at sea which have to approach certain parts of the British Isles during their course to install beacons and fog-signals in isolated positions, the fog-signals to be sounded at intervals of about 30 seconds whenever the prevalence of fog renders such a warning of danger essential. A lighthouse with a tower containing motors, compressors, fog-horn and light, but quite unattended, although over a mile from the shore, was shown in the illustration with accompanying letterpress of the Platte Fougère lighthouse, off the coast of Guernsey, in the SCIENTIFIC AMERICAN of May 30th last, but this is connected by a submarine cable with the shore station, where the keepers and engine, etc., for the alternators are housed. The Clyde Lighthouse Trust also have an automatic beacon in the shape of a very powerful acetylene light at Garroch Head, which is unattended, but yet flashes at regular intervals all night and every night, but turns itself down automatically during the daytime.

Automatic Fog Guns.

They have further provided automatic acetylene gas-guns as fog-signals. These, once set going, would continue to feed and fire themselves at proper intervals until the fuel should become exhausted, which would occur only after several weeks. These guns are the outcome of an idea which emanated from Messrs. D. and C. Stevenson of Edinburgh, engineers to the Commissioners of Northern Lighthouses. They are of the utmost service to shipping in foggy weather since they not only warn passing vessels that they are near danger, but they can be regulated to fire at precise intervals, variable for each gun, and thus denote their whereabouts on the coast and enable the captains of ships to verify the approximate positions of their vessels at a time when visual observation may be impossible. Of course it would be wasteful and a nuisance to the public to have fog-signals going continuously when there was no fog, and similar arrangements to those at Platte Fougère could have been made to turn on the gas-gun with the oncoming of fog by submarine cable and turn it off again when the weather cleared. The expense, however, would be considerable, and although the gun itself is so constructed as to be unaffected by changes of weather, the cable might conceivably break down during a storm, and this would be doubly dangerous, because if it happened before the weather became foggy, the gun would not be firing when wanted, and shipping would be endangered by a false sense of security, for the captains of vessels, knowing the guns to be in certain positions, and not hearing the reports, would imagine they were clear of danger.

Wireless Control Suggested.

The automatic apparatus of the Garroch headlight was found to be susceptible to outside influences, and the Marconi's Wireless Telegraph Company was approached with a view to providing an installation which could be set going and turned at will from a distance in order to start and stop the firing of the guns.

Their research department accordingly set to work, and in a comparatively short time solved the problem. It must be remembered that the difficulty of solution was increased by the fact that the apparatus in direct mechanical connection with the guns, that is, the "receiving" station, has to be left entirely without attention for long periods, during which it is not only exposed to the vagaries of climate and weather, but subjected from time to time to all sorts and conditions of signals from wireless apparatus from passing ships, which are far more powerful than the controlling signals, but which nevertheless must not be permitted to influence the "control." Moreover, the transmitting plant on shore, which actuates the district "receiving" station, has to be left in the hands of men who know nothing about the Marconi or any other wireless apparatus, and who must work the control on simple but definite directions involving no exercise of technical skill or knowledge.

How the Gun is Operated.

In order to illustrate how this is done, it is well to commence with a description of the Stevenson-Moyes acetylene gun, a drawing of which is given in Fig. 1. The gas is provided either by a carbide-to-water plant or from cylinders of acetylene dissolved in acetone, and is led through the stop-cock *B* into the expanding bellows *A*. As the gas enters, it opens out the bellows, driving up the rod *D*, and with it the inner container *E* of the air-gasometer (which is counter-balanced by the weight *C*), thus drawing air in through the air-box *F*. As *E* rises it drives upward the rod *I*, which performs two functions: The first is to wind up, against the action of a spring, an emery wheel in the ignition chamber *H*, which leads into the base of the gun *G*. The second function is to actuate a trip-gear which, when the container *E* has reached the correct height, suddenly closes the gas admission valve and opens another valve which allows both the charge of air in *E* and the charge of gas in *A* to flow together into the gun, in which they form an explosive mixture, correctly proportioned by the respective volumes of *A* and *E* (about 1:15). At this moment the rod *I* releases the emery wheel, which gives a vigorous half-revolution. Pressing against this wheel is the end of a rod of a special sparking metal *J*, forced down with uniform pressure by two weights. As the emery wheel gives its half-turn against the end of this rod it throws off a stream of sparks which fire the explosive mixture in the gun.

The muzzle of the gun opens into a chamber *L*, whose walls are composed of several concentric layers of metal net, each layer being spaced about half an inch from the next. These layers of net serve to keep the spray, even in the heaviest seas, from entering the muzzle, whereas they allow the explosion, reflected by the thick metal disk *K*, to pass out in all directions. The position of *K* above the muzzle is of importance, and an adjustment is provided by which this position is regulated and the gun properly "timed."

Action Automatic and Continuous.

As soon as the charges of gas and air from *A* and *F* have been passed together into the gun, connection with the latter is automatically cut off and the gas admission valve into *A* is opened, so that the whole process is repeated. The time occupied by each cycle depends on the rate at which the gas is allowed to enter, so that the number of signals fired in a minute can be regulated in this way.

It is clear that this process will go on repeating itself with perfect regularity until the supply of gas is exhausted, which would be in two, three, or four weeks time, according to the size of the generator. But by the installation of the wireless control gear the supply of gas can be turned on and off whenever desired, and as a result the gun can be left for a period of several months without attention, since it can be started whenever the weather becomes foggy and stopped as soon as it clears.

The Marconi Control.

The Marconi Company's wireless control is shown in Fig. 2. On the left of Fig. 1 is the Marconi gas-admission valve, which is introduced between the gas-generator of the Stevenson-Moyes acetylene gun and the stopcock *B*. This is a needle-valve controlled by two electro magnets, so arranged that when the first magnet is energized the valve opens wide and allows the gas to pass freely, while when the second magnet is energized, it shuts the valve firmly, so as to be gas-tight even against a pressure of 20 pounds per square inch—a valve considerably in excess of the maximum pressure in use with this gun.

Next to this valve is seen the water-tight metal box containing the wireless receiving gear, part of the box

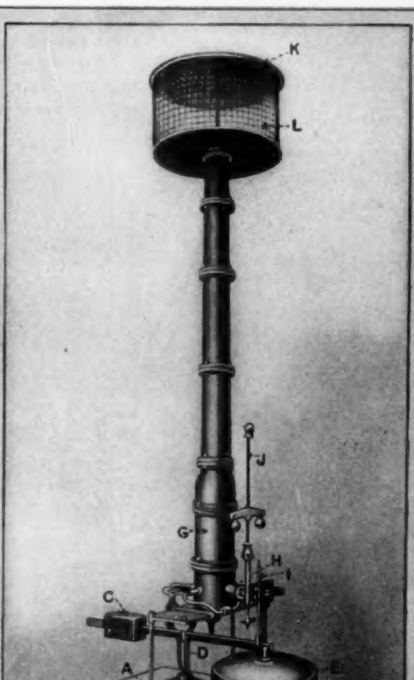


FIG. 1.—OPERATING MECHANISM OF THE STEVENSON-MOYES FOG GUN.

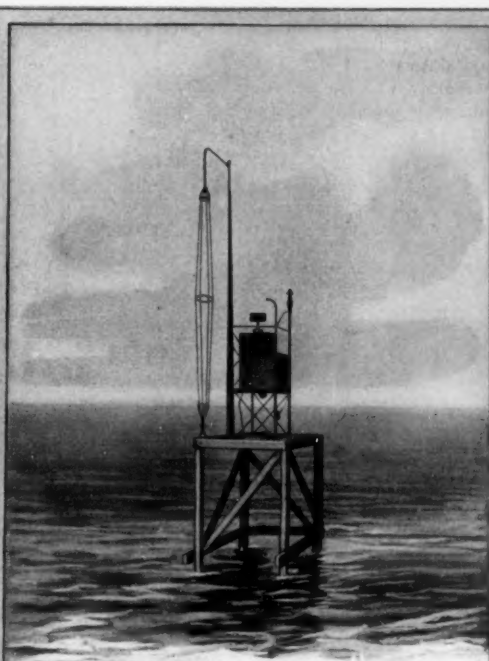


FIG. 4.—WIRELESS FOG SIGNAL AT ROSENEATH PATCH ON THE CLYDE.

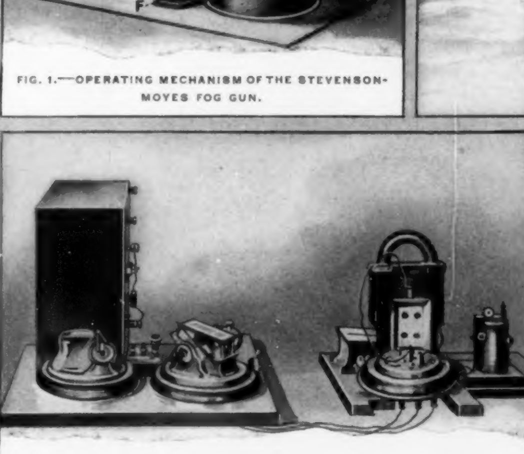


FIG. 3.—MARCONI CONTROL APPARATUS. RELAY AT THE RIGHT.

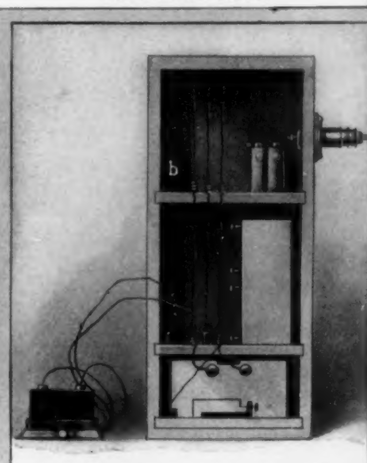


FIG. 2.—MARCONI WIRELESS CONTROL.

Wirelessly-controlled beacons.

(*Concluded on page 430.*)

August Weismann the Apostle of Germ Plasm

The Life Work of a Great Biologist Reviewed

By Benjamin C. Gruenberg

IN the evolution of evolution theories, the late August Weismann will have a place as the victor over what Darwin called "the Lamarckian nonsense." But he will be remembered for more than challenging the idea of transmission of parental modifications. His positive contributions to evolutionary thought have been receiving increasing consideration and appreciation in more recent years. The theory of the continuity of the germ-plasm, the theory of amphimixis as the source of variations, the theory of heredity resting on the concept of the germ-plasm, and the theory of germinal selection constitute, on the side of evolutionary thought, Weismann's chief contributions to the science of the last half-century. His studies in the development of flies and of water-fleas developed a technique for the study of embryology which has been of great value to other students, aside from the facts that he himself discovered.

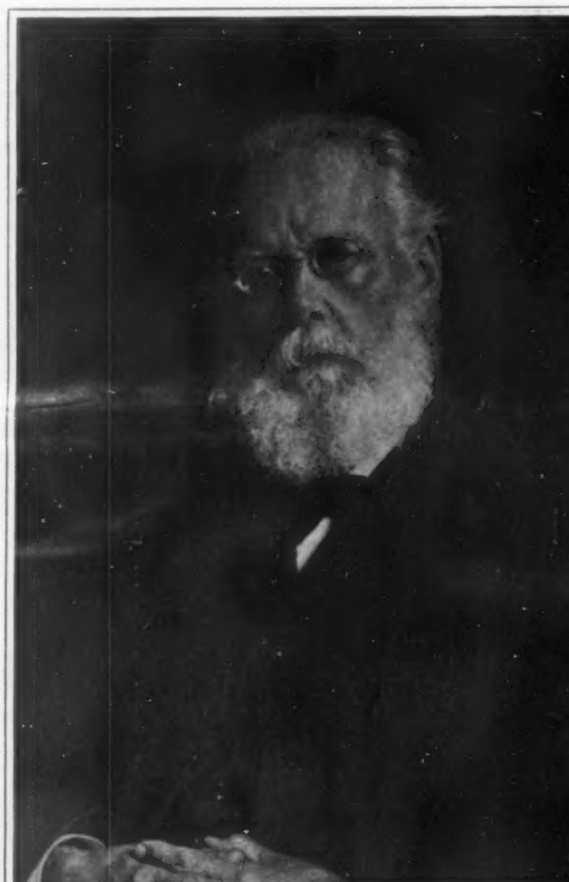
August Weismann was born in Frankfort-on-the-Main, the son of a teacher of literature. He received his early schooling in his native town, and at 18 years of age he went to the University of Göttingen, where he prepared for the practice of medicine. This practice did not hold his interest, and a few years after getting his diploma he went to Giessen to study zoölogy with Leuchart. He was so successful in his studies on the embryology of the two-winged insects that he decided to apply his methods to other groups of animals. In 1863 he became professor of zoölogy at the University of Freiburg, where he remained for the rest of his life. Shortly after becoming a professor, his eyesight became so weakened that he was unable to use the microscope for about ten years. During this time it was necessary to suspend all research work, and most of his reading and writing had to be done with the help of others.

This period of enforced abstention from work with the microscope probably contributed very largely to the development of those speculations which form so prominent and distinctive a part of his life's work. In 1874, while resting at Lake Constance, he found a water-flea of a kind that was new to him, and was much impressed with its availability for microscopic study, on account of its transparency. At that time the modern microscopic technique was still in its infancy, and one was compelled to choose material for study not according to immediate needs, but according to the condition of materials that came to hand. Weismann decided to make a study of the Daphnids. In this group he worked out many of the physiological processes as well as the development and life-history, finding the relation of the alternation of sexual and asexual generations to external conditions. From these studies he passed to the eggs of the jellyfish, on which he published a monograph in 1883. In the meanwhile, in 1881, he had made a study of the relative length of life in different groups of animals, from which he concluded that the duration of life in any species was an adaptation to the conditions under which the species lived, and that physiological death was not a general phenomenon, since the lowest animals, the protozoa, never die except as the result of some violence. From this it was but a step to the idea of the germ cell, and then to the continuity of the germ plasm—ideas the development of which occupied his best thought for the next twenty years.

In practical consistence with his repeated demand that the Lamarckian system of thought, the assumption of the transmission of changes in the parents—or of "acquired characters," as they are sometimes called—be supported by suitable evidence, he himself started some experiments. After analyzing all the alleged evidence of such transmissions, and after finding that the removal of the tails from twenty-two generations of rats had no measurable effect on the length of tails still produced, he came to the conclusion that such transmissions have not been proven. This conclusion, though negative in form, was a real contribution to the progress of science, since it cleared the ground of a great deal of misconception and unwarranted assumption. His own experiments were followed by those of other workers, and so far the results, with the exception of some very recent experiments that have not yet been thoroughly analyzed, still support the negative conclusion that modifications in the body of an organism are not reproduced in the offspring. The fact that alcoholism does not show an influence upon the offspring can be explained on the Weismannian hypothesis without resorting to the Lamarckian explanation.

Weismann rejected the Lamarckian theory only partly on the failure of the evidence. From the nature of his own mind, the lack of evidence was not the chief obstacle. The impossibility of conceiving a mechanism that would account for the facts of organic inheritance and at the same time permit the transmission of modifications, was to Weismann the greater difficulty. Darwin's theory of pangenesis attempted to meet the requirements, but failed to do so. Weismann's original position was summarized by him as follows:

1. Acquired characters are such as result from external influences upon the organism, in contrast to such as spring from the constitution of the germ.
2. Characters can be inherited only in so far as their rudiments ("Anlagen") are already present in the germ-plasm.
3. Modifications which are produced upon the formed body in consequence of external conditions must remain limited to the organism in which they arose.
4. The same is true of mutilations, and of the results of use or of disuse of the parts of the body.
5. No such modifications of the soma (the tissues and organs of the body, as distinguished from the reproductive cells)—that is, such as are produced by the environment or by the functions of the organism—can be transmitted to the germ-cells, from which the next generation arises. They are therefore of no account in the transformation of species.
6. The only principle that remains for the explanation of the transformation of a species is direct germinal variation. These speculations led to the apparently paradoxical conclusion that the child is not the offspring of the *body* of its parent, but inherits its constitution and characters from the parental germ-cells; but these in turn owe their characters, not to the bodies which bore them, but to the germ-cells from which these bodies were developed. The body is, in fact, the offshoot of the germ-cell, not the germ-cell the offshoot of the body. According to this view the body is simply the *carrier* of the germ-plasm, which is self-perpetuating or "immortal," in the sense that it maintains its identity from generation to generation.



August Weismann

It must not be supposed that the idea of the continuity of the germ-plasm was altogether new with Weismann. It is one of those fertile aspirations that arise spontaneously in the minds of many men. This idea was first clearly expressed early in the nineteenth century by the anatomist Owen; later we find it in the writings of Virchow, the founder of modern pathology, who, in 1858, put it forth as part of his general doctrine, "All cells from cells;" it was also part of Haeckel's system of general morphology, as an incident to his doctrine of the continuity of parent and offspring; it was independently formulated by Nussbaum and by Jaeger, who in 1878 spoke of the continuity of the germ protoplasm which is inclosed within the body of the developing organism, but reserved to produce future generations. In this country, about the same time, the late W. K. Brooks gave expression to a very similar account of the function of the fertilized egg in producing on the one hand a series of cells that are to form the body of the individual, and on the other hand a series of reproductive elements that are to develop into later generations of organisms.

Weismann laid stress on the germ *plasm* rather than on the germ cell, and he located this plasm in the nucleus of the reproductive cell. More specifically, the plasm must reside in the chromotin of the nucleus. Weismann pointed out that the germ-plasm must be conceived of as having a very complex structure, since it has been exposed for thousands of generations to the action of such external influences as may reach it through the vicissitudes of the organisms in which it has been successively carried. He postulated certain elementary biological units, the *biophores*, comparable to the hypothetical "gemmules" of Darwin, and the "pangens" of De Vries. These units were supposed to be combined into groups called "determinants," one of those corresponding to each cell or group of cells that constitute a definite character in the development of the organism. That is, the presence of a determinant in the germ-plasm determines a certain development; another determinant in its place would bring about a different character in the organism. These determinants are aggregated into still higher units, called "ids," each of which is supposed to contain a complete architectural outfit for all the characters of the species. These units are visible with the aid of a microscope, and correspond to the chromatin granules. A number of these ids together make up an "idant," and among them there is individual variation. The idants have been identified with the chromosomes.

Now, while this series of subordinate units may seem like a very complex and artificial system of speculations, it is significant that certain deductions made from these hypotheses have been verified by direct observation. In 1897 Weismann said that there must be two kinds of nuclear divisions, if his theory of the constitution of the germ-plasm was true. There would be first the division in which each chromosome is split lengthwise, so that each new nucleus receives an exact half of each id. Then there must be another kind of cell division in which the chromosomes are so split as to give to each new cell only one-half of the ids present in the mother-nucleus. The former kind of nuclear division was then well known to occur in the course of all normal cell division in the

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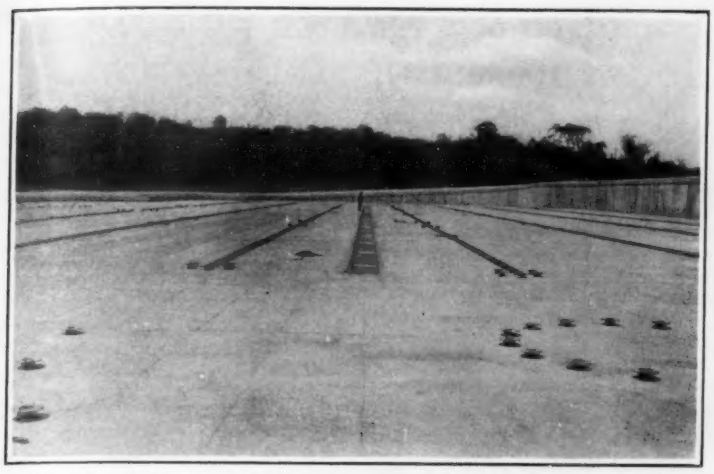
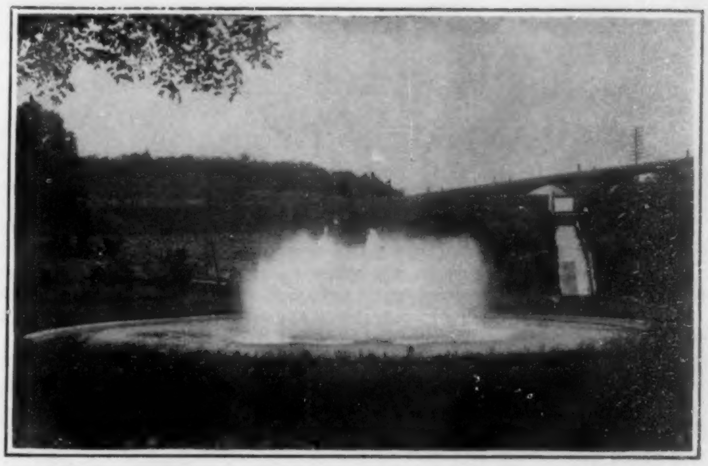


Kensico aerator basin, showing the nozzles and the central outlet slot.

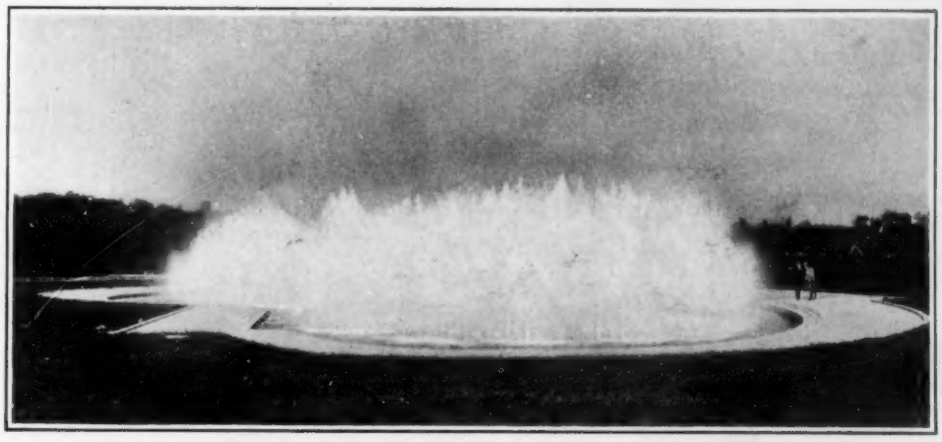


The experimental aerator at the Rye outlet of the Kensico reservoir.

Mammoth Aerator for New York's Water Supply

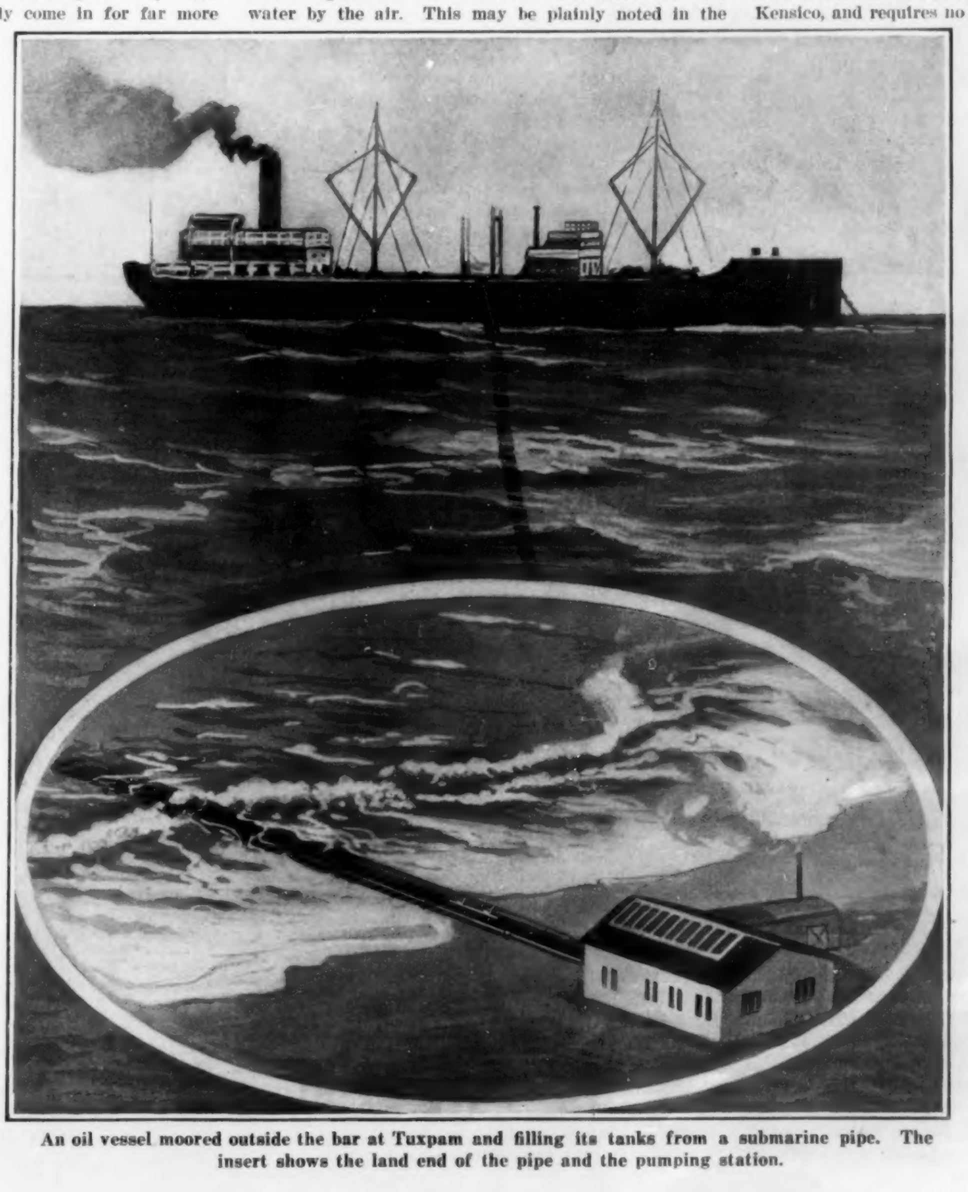
ALTHOUGH, unfortunately, much of the magnificent engineering work on the great Catskill Aqueduct of New York city must lie buried far underground, there are many outcroppings here and there that will give the taxpayer some idea of the wonderful water supply system his money has bought. Undoubtedly the most spectacular features will be the two mammoth aerators, one at Ashokan, where the water may be purified before entering the aqueduct, and the other at Kensico, where the water may be purified again before entering the city. The latter aerator will undoubtedly come in for far more attention than the former, owing to its proximity to the city. Visitors will find it well worth their while to make the trip to this spot where the great aerator is in full operation.

In a park setting, laid out by a landscape architect, is the enormous basin covering three acres, and measuring 460 feet in length by 240 in width at the widest part. The floor of this basin is studded with nozzles arranged in rows. There are 1,600 nozzles altogether, and when the aerator is in full operation each will spout a jet of water from fifteen to twenty feet high. The water will issue in fan-shaped, whirling fountains, which, owing to the close spacing of the nozzles, will intersect and break up the water into a mass of spray. Along the edges of the basin and at the ends of the rows of nozzles, there are groups of nozzles, some arranged to project a taller fountain than others, and all being designed to produce a very artistic effect. As the sun-light strikes the spray from these hundreds of fountains, it will be broken up into rainbows. By breaking up the water into spray, it will be brought into intimate contact with the air, which will thus oxidize some of its impurities. Aeration will be particularly needed in the fall when water, standing in lakes, is liable to acquire an unpleasant taste, due to microscopic vegetable growths. The one drawback to this spectacular feature of the aqueduct will be the odor extracted from the water by the air. This may be plainly noted in the small experimental aerator now in service just below the Rye dike of the reservoir. A photograph of this aerator is reproduced herewith.



The Kensico aerator as it will look when aerating the water of the Catskill aqueduct.

One of the pictures shows how the large aerator will look when the water is turned on. Another is a photograph of the basin as it now looks, showing the rows of nozzles and the broad slot, covered with an iron grating, that runs down the middle of the basin, and through which the water will pour into the aqueduct. The water in the basin will be very shallow, as it will pour off quickly through the outlet slot. The aerator at Ashokan is almost identical in design and construction with that at Kensico, and requires no separate description.



An oil vessel moored outside the bar at Tuxpam and filling its tanks from a submarine pipe. The insert shows the land end of the pipe and the pumping station.

The Shipment of Petroleum at Sea by Submarine Pipes

MEXICO appears destined to become the world's principal source of petroleum. Rich oil fields, situated near the Gulf of Mexico, have been worked for several years, although the transportation, and especially the shipment of the oil, present great difficulties, due chiefly to the defective organization and equipment of the ports.

The principal ports of this coast are Tampico, Vera Cruz, and Puerto Mexico. Most of the oil is shipped at Tampico, but a considerable and steadily increasing quantity is exported from Tuxpam, the nearest point of the coast to the oil field of Potrero del Llano. Tuxpam possesses neither shipping facilities nor a breakwater inside which vessels can find shelter. Moreover, a bar like that of Casablanca sometimes prevents vessels from entering or leaving the harbor for several days.

The company that operates the wells of Potrero del Llano has adopted an ingenious device for overcoming these obstacles to the shipment of its oil. It has laid submarine pipes which, starting from the shore, cross the bar and terminate in flexible pipes, supported by buoys. The oil is forced through the pipes by pumps placed in a building near the shore.

The first installation

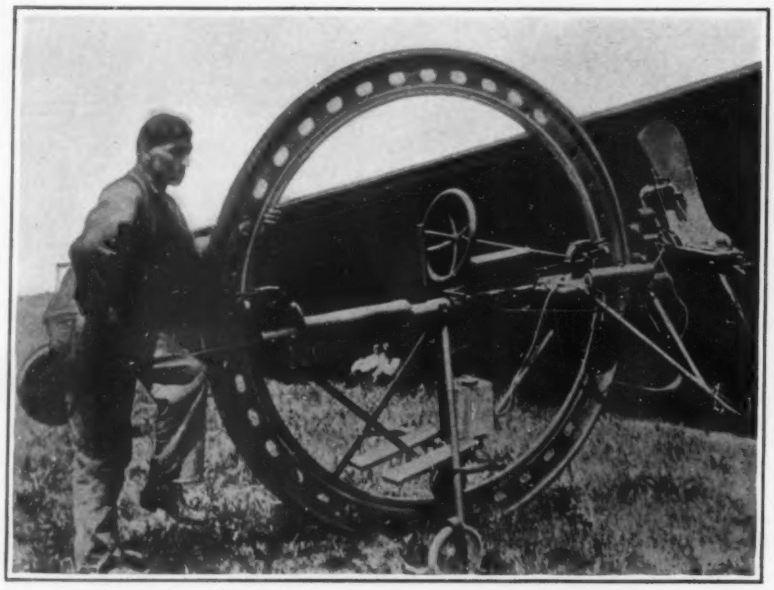
(Concluded on page 429.)

Inventions New and Interesting

Simple Patent Law; Patent Office News; Notes on Trademarks

A Propeller-driven Unicycle

THE peculiar motor vehicle shown in the accompanying engraving claims a speed of 70 miles an hour, made in St. Louis, where it was built and tried out. The device is driven by an air propeller, which is operated by means of a gasoline engine. The big single wheel has a diameter of 81 inches, and is of aluminium, with a solid rubber tire. The rider sits on a saddle within the big wheel, and the frame which supports him, as well as the motor, propeller, gasoline, and oil tanks, etc., is suspended so that the wheel revolves about it, leaving the frame in the same upright position all the time. This is achieved by a system of fiber bearings in contact with the inner rim of the unicycle. Two rollers and a pair of skids are located at the sides of the big wheel, and their purpose is to keep it erect while at rest. When traveling, the device balances like a hoop, of course, and these lateral supports are lifted off the ground. No stranger sight can be imagined than this exaggerated hoop, bearing down the road at racing speed.



A unicycle driven by an aeroplane propeller.

Electrical Music

THADDEUS CAHILL, a well known Washington inventor, in patent 1,107,261, assigned to Ellis Spear and others, trustees, provides for producing music electrically and for distributing music electrically from one generating place or central station to many receiving points so that persons at their respective homes can hear and enjoy music produced at a central station.

Non-glaring Headlight

GLARE has been defined as a misplaced light; and blinding and glare effects from headlights are due entirely to improperly designed reflectors and unsatisfactory combinations of lamps and reflectors. Carl and Albert Matisse of New York have recently patented a sphero-paraboloid reflector which is shallow and which concentrates a beam of light within a small angle, but illuminates a wide area in front and extends well out to the sides of the reflector, and which is devoid of glaring effect. The reflector is ground from special glass into a concavo-convex lens (see Fig. 1). The convex-paraboloidal surface is silvered, in airtight contact therewith, and re-enforced with electro-plating of copper, and further protected by a non-corrosive, heat resisting paint. The exposed concave spherical glass surface cannot tarnish, and is easily kept clean without danger of injuring the reflecting surface, which makes the reflector substantially everlasting. The reflector confines the light reaching it, from a light source in the focus of the reflector, within a small angle of three degrees. Fig. 2 shows the result of a test by the Electric Testing Laboratories, New York, comparing the illuminating of this glass lens reflector with a metal one shown in Fig. 3.

The width of roadway covered by the light beam from the lens reflector is 10½ feet at 200 feet, and 31 feet at 600 feet. The lens reflector being only 3½ inches deep and 10 inches in diameter, with the source of light in the focus, only 33 per cent of the light is effective on the reflector, practically all of which is concentrated into the road beam. Sixty-seven per cent of the light from the source is available and used immediately in front and to each side of the reflector, whereby a wide area of illumination in front and extending well out to the sides is obtained. This light is vital for crossings and turns. For perfect adjustment of the source of light in the focus of the reflector, the source is mounted adjustably in the axis of the reflector. When utilizing the reflectors for automobile headlights, the source of light is mounted not only adjustably to the axis, but to be thrown out of the axis, whereby the beam of light may be directed upon the roadway within a hundred feet of the car.

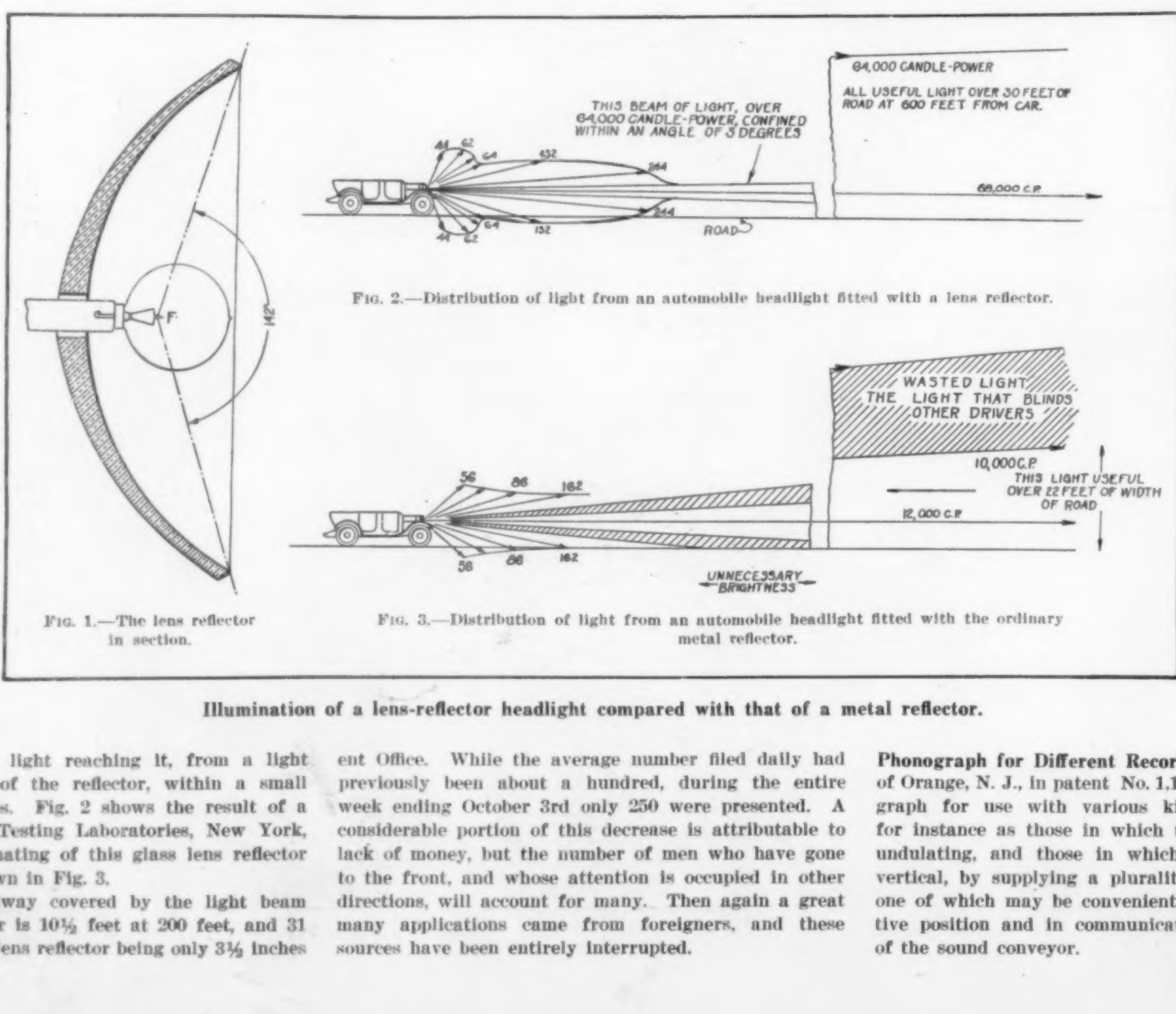


FIG. 1.—The lens reflector in section.

FIG. 2.—Distribution of light from an automobile headlight fitted with a lens reflector.

FIG. 3.—Distribution of light from an automobile headlight fitted with the ordinary metal reflector.

Illumination of a lens-reflector headlight compared with that of a metal reflector.

War and Patents in England.—One of the results of the war has been a very marked decrease in the number of patent applications filed in the British Patent Office. While the average number filed daily had previously been about a hundred, during the entire week ending October 3rd only 250 were presented. A considerable portion of this decrease is attributable to lack of money, but the number of men who have gone to the front, and whose attention is occupied in other directions, will account for many. Then again a great many applications came from foreigners, and these sources have been entirely interrupted.

Table Syrup from Apples

THE head of the fruit and vegetable utilization laboratory of the Department of Agriculture has, it is reported, applied for a public service patent covering the making of a new form of table syrup from apple juice. By this patent, the result of extensive experiments, the discovery, which the specialists believe will be of great value to all apple growers as a means of utilizing their culls and excess apples, will become the common property of any cider mill in the United States which wishes to manufacture and sell the product.

The new syrup, one gallon of which is made from seven gallons of ordinary cider, is said to be of an attractive color, and, sterilized and sealed, will keep indefinitely, and is claimed will keep under household conditions as well as other syrups. Its flavor is described as similar to the taste of the syrupy substance which exudes from a baked apple.

A cider mill in the Hood River Valley, Oregon, will this fall undertake to manufacture and test on the retail market 1,000 gallons of concentrated cider, which will represent 5,000 gallons of ordinary apple cider with only the water removed.

Destruction of Private Papers and Checks

EVERY concern must find some method of disposing of its accumulation of private or confidential papers which have outlived their usefulness.

Many cumbersome methods have been devised and in some cases it is necessary for the treasurer of a company to have old voucher records carried to the furnace room, and he be obliged to stand by until the records are destroyed.

A large number of firms have adopted schedules, and they destroy vouchers five, six, or seven years old. Private correspondence has a limit of usefulness, as have orders, requisitions, etc.

There has now been provided for the treasurer's office a "macerating machine," which can be operated by hand or motor power. In operation the papers to be destroyed are fed into the machine from a table located at the top; upon entering a receptacle the papers come in contact with circular knives made of tool steel.

After passing the rotary knives the fragments falling by gravity through a trough into a box or other receptacle, are destroyed beyond all means of identification.

This method will no doubt find great favor with all business houses where it is necessary to destroy papers in any quantity, as the work can be done in the accounting offices without loss of time by the executives.

Adapting the Phonograph for Different Records.—Walter H. Miller of Orange, N. J., in patent No. 1,108,208, adapts a phonograph for use with various kinds of records, such for instance as those in which the groove is laterally undulating, and those in which the undulations are vertical, by supplying a plurality of reproducers, any one of which may be conveniently brought into operative position and in communication with the interior of the sound conveyor.

The Naval Fights in the Pacific and Indian Oceans

(*Concluded from page 421.*)

"Emden" was coaling off Rangoon. A few days later she captured, took her coal aboard, and sank the "City of Winchester." A month later she turned up in the Bay of Bengal and captured and sank six vessels of from 3,400 to 7,600 tons. Then, after the lapse of another week, she was off Madras, where she dropped a few shells into the shipping of the harbor and bombarded and fired the oil tanks. At the end of September she captured four more vessels and sank them, using a fifth vessel as a ship for the prisoners. By this time several British cruisers had been sent in pursuit, but although they frequently caught sight of her, and captured her colliers and transports, she escaped them. Toward the close of October she carried through successfully a daring feat at Penang on Malacca Straits. Rigging up a fourth smokestack, and flying the Japanese flag, she steamed slowly, unchallenged, past the guns of the British fort, torpedoed the Russian cruiser "Jemtchug" and a French destroyer, and escaped unharmed.

Finally, after destroying between 25 and 30 ships, the "Emden" was caught by the fast Australian scout-cruiser "Sydney," sister ship to the "Chatham" and her class, and after a running fight, in which she lost two of her smokestacks and was set on fire, the "Emden" was driven ashore and burned.

The cruise of this vessel, her pluck, and her chivalrous treatment of the captured crews, have won for her the admiration of her enemies. In speaking of her destruction, the London *Times* said:

"We rejoice that the cruiser 'Emden' has been destroyed at last, but we salute Capt. von Müller as a brave and chivalrous foe. We trust his life has been saved, for if he came to London he would receive a generous welcome.

"Our maritime race knows how to admire a daring and resourceful seaman, and there are few episodes of modern naval history more remarkable than the meteoric career of the little 'Emden.'"

The "Koenigsberg" was reported about the same time as having been caught by the "Chatham" in a small inlet on the German East African coast in water too shallow for the "Chatham." A collier was sunk at the entrance, and the depredations of this ship were thus brought to an end.

The Shipment of Petroleum at Sea

(*Concluded from page 427.*)

consisted of two 6-inch pipes, of which one extended 3,600 feet and the other 5,150 feet from the shore. These pipes were laid by means of lighters. This method proved to be laborious and objectionable, as it caused some of the joints to leak. The newer pipes were laid by the following method: A runway, formed of heavy planking, with lateral guide rails or flanges, was constructed on shore, in the line of prolongation of the submarine pipe and at the level of high water. The sections of the pipe were assembled on the runway, which was as long as the whole pipe. When the sections had been joined the pipe was lifted and laid on carriages, placed 40 feet apart, each of which was mounted on a single wheel, nearly as wide as the runway. Before immersion the pipe was covered with two layers of canvas, coated with hot tar.

The pipe was drawn into the water by a vessel which approached within 1,600 feet of the shore and was attached to the pipe by a steel cable. When the submarine pipe was in position a diver attached to its outer end a flexible pipe composed of six sections, each twenty feet long, and fastened the end of the flexible pipe to a buoy. As the depth of water is only 43 feet, the length of the flexible pipe, 120 feet, is sufficient to allow its end to be brought on board a vessel without causing excessive tension. When the oil vessel is ready to fill its tanks it displays a signal to which the pumping station responds by starting its pumps. Six submarine pipes are now in use and two additional ones will soon be laid.—*La Science et la vie.*

Wirelessly-controlled Beacons

(Concluded from page 425.)

being removed to show the apparatus arranged on three shelves (Fig. 2.)

Connection to the receiving aerial is made through the insulator seen projecting on the right. The received signals pass to the "jigger" primary and thence to earth through a terminal passing through the wall. The "jigger" secondary goes to the actual detector—a special form of coherer seen on the right of the top shelf. This detector actuates a special relay (*b*) on the left of the top shelf, which is so constructed that, although very sensitive, it has a large movement, and is, therefore, capable of keeping in adjustment under all kinds of temperature conditions. This end is further insured by the provision of counter-balancing springs. This relay is seen on the right of Fig. 3.

The "Synchronizers" Play an Important Part.

On the left of this figure is seen one of the two "synchronizers," which form an essential part of the apparatus, rendering it perfectly immune from the two great troubles of "wireless"—atmospherics and "interference" from powerful signals from passing ships—and enabling the same apparatus to perform two distinct functions—turning "on" the gas valve and turning it "off."

Each synchronizer is connected to one of the two electro-magnets of the gas valve described above, so that when one synchronizer is actuated by the relay it energizes the one magnet and opens the valve, which remains fully open until the second synchronizer, actuated by the same relay, energizes the second magnet and closes the valve. A clockwork mechanism which runs for six months with one winding is included, and performs a useful and necessary function. Every ten minutes it operates a small hammer that strikes a sharp blow which jars the relay contacts, gets rid of any "stickiness" which might develop after several months, either in the pivots or at the contacts themselves, and at the same time causes a momentary current to pass through the decoherer.

The lower shelf contains in Fig. 2 the battery of dry cells which provides the driving power for the whole receiving apparatus. A small four-fold aerial, supported from a mast about 14 feet high, completes the receiving apparatus.

The Transmitting Apparatus.

The transmitting apparatus, installed on shore and under the charge of the coast guards, is simplicity itself. For short distances, such as 4-mile communication, it consists of a 10-inch coil driven off accumulators, a transmitting jigger and condenser and the transmitting "synchronizers" corresponding to those of the receiving set. For greater distances the same apparatus will serve, provided greater aerial height is available; failing this a small alternator provides the additional power required. Two sets of the apparatus just described are now working on the Clyde. One situated at Roseneath Patch, being shown in the illustration; and is operated from the coast guard station at Gourock. The other station is at Fort Matilda. Other sets are to be installed shortly, and the field opened for the application of this particular form of wireless control is so large that the company is busy designing sets for greater distances.

System Widely Applicable.

The article in the *Wireless World*, published by the Marconi Press Agency, from whom the details here given were obtained, makes the following suggestions: Putting aside for the present those applications which may be classed under the heading of "warfare" and keeping to those which deal with the preservation of life, it is suggested that in order to promote safety in mines, a small box, which could be carried by the miners as they progressed into out-of-the-way cuttings, in combination with a few feet of insulated wire, as aerial, would keep them in constant touch with the surface; so that, if the master alarm at the pit head were set going, the alarm would reach every part of the mine at once; or, if desired, any selected gallery could be cleared without disturbing the workers in the rest of the mine.

In other spheres of usefulness fresh suggestions present themselves on every side. Alarm signals for ships in fog, worked on a small separate aerial, and in no way affecting the ordinary wireless, would infallibly call the attention of the captain of a ship to the presence of another ship within a distance of say four miles, in a fog which may deaden the carrying power of the siren. All these form but a fraction of the possible applications which present themselves for this invaluable development of wireless control, which should have a beneficent effect on human intercourse in many ways.

August Weismann

(Continued from page 426.)

bodies of plants and animals. The second type was not known to occur, but Weismann predicted that it would be found to take the place in the formation of sperm-cells and in the separation of the "polar bodies" during the formation of egg cells. This type of division, which Weismann called a "reducing division," since it resulted in reducing the number of units in the daughter-nuclei to one-half the number present in the mother-nucleus, has been found to occur in so many of the plants and animals examined that it is now spoken of among biologists as the normal process in the maturation of sex-cells. Those who deprecate the speculations of Weismann as being "purely speculative" should give these theories the credit of being able to *predict*, which is the test demanded of all scientific theories.

The facts of nuclear division are of great importance in relation to a theory of sex, and it was in this connection that Weismann chiefly worked them out. It was his theory that the function of sex was to secure for a species a degree of variability through the combination of ids (with their determinants) from different sources. Since the number of these would double with each fertilization, leading to ever greater complexity of constitution, he was led to the theory of the linear arrangement of ids in the chromosomes, with the reduction of the number before fertilization, and a restoration of the number by the fusion of the two germ-cells. While the later study of the mechanism of the nucleus has borne out Weismann's theory at every point, his views on the causes of variation have not been supported by experiments. The application of mathematical methods to the study of variation has brought out the fact that the range of variation is as great among animals or plants that are produced without egg-fertilization, as among those in which "amphimixis" or the fusion of germ-plasm from two individuals does take place.

Weismann's theory of heredity is a part of the theory of the continuity of the germ-plasm, and of the constitution of the same. The germ-plasm is made up of biophores, self-propagating vital units, united into determinants. When a fertilized egg-cell begins to segment into cells that are to form a new individual, some of the germ-plasm is set aside to become later germ material of succeeding generations. Identifying the chromosomes with the idants, or chains of ids, makes the chromosomes the bearers of hereditary qualities. The same conclusions were reached at about the same time and independently, as a result of direct studies, by the botanist Edouard Strasburger and the zoölogist Oscar Hertwig. According to this theory there can be no "transmission of acquired characters," because there is no mechanism by which the effects of environment, of mutilations or of uses and disuse, can influence the germ plasm in a way that will change the determinants so that they shall *determine* development in the following generations corresponding to the parental modifications. On the other hand this theory does explain not only the fact of the reappearance of characters in parents and offspring, but also the fact of diversity; since the combination of ids is never the same in any two germ-cells. This theory is also in harmony with the recent discoveries in the laws of heredity based on experimental methods.

Weismann was a firm believer in the

Darwinian doctrine of evolution through natural selection, although he was ready to acknowledge that the theory, as Darwin left it, was far from adequate. In fact his whole life work may be considered an attempt to strengthen the weak points in Darwin's theory. The one point that seemed to him the weakest was the question of the origin of variations in just those directions that secure evolution in some definite line. He rejected the idea that there was something innate in living matter that compelled evolution along some certain lines rather than along others. His explanation rested on an extension of the principle of selection to the units that make up the germ-plasm. The theory of germinal selection supposes that the vigor and development of the ids depend upon the conditions of their growth, and that as there is competition among these units, the survivors will determine not only the character of the individuals that are to develop from the germ-plasm, but also the character of the germ-plasm of the succeeding generations. In other words, natural selection, by determining which individuals are to survive and leave progeny, also determines the character of the germ-plasm and the direction of variations. This theory, first suggested by Weismann in his famous reply to Spencer's essay on the inadequacy of natural selection, he considered a necessary complement to Darwin's theory, since only by its means could he reconcile the contradiction between the assumption of general fitness of organisms on the one hand, and the assumption of the origin of this fitness from accidental variations on the other. He admitted that primary variations must have been accidental, but insisted that continued variations must have been directed by some internal mechanism, once selection had begun to act.

Weismann started his speculation upon heredity a firm believer in the principle of "epigenesis," or development under the influence of external conditions, as against the older, discredited theory of "Preformation," or the development of parts already existing in the ovum, but as his system of thought expanded he found himself obliged to reject the generally accepted epigenetic view and to work out a new phase of preformationism. The determinants of Weismann's system, although not actual miniatures of the parts of the organism, he nevertheless considered as *representative* units which are present in the fertilized egg from the very first, and which are transmitted to the offspring as stable units. But in applying the theory of determinants to the facts of regeneration, or the regrowth of lost parts, he found that he met the same difficulties as were opposed to Darwin's Gemmules. If, for example, it is the determinants in the cells of the lobster's claw that determine the development and size of that claw, how can the cells of the neighboring organs proliferate into a new claw when the old claw is removed? If the explanation of the facts is removed to the general properties of the lobster's protoplasm, the location of the injury, etc., then there is an abandonment of the determinants as the specific agents in claw-making. If on the other hand we resort, as did Darwin with his gemmules, to Weismann's "accessory determinants"—that is, inactive claw-determinants lying dormant in the neighboring cells and becoming active only under the stimulus of the local injury—then there is an abandonment of the specificity of the determinants and a sliding back into epigenesis.

The determinant theory has the same difficulties to meet in the case of a segmenting egg which, when broken into its two or four or eight, or even more, several cells, will develop a perfect individual from *each* of the cells. According to the theory, the development of the individual is a process of differentiating divisions of the germ-plasm, in the course of which representative particles or primary constituents are distributed to make up the various parts of the organism. According to the facts, a small group of cells, as some cells of a begonia-leaf, or of a willow stem, or of a piece of a hydra, may develop into a complete individual; or, as in the cases cited, a single cell, not itself a germ cell, may develop into a complete individual. Whatever of truth there is in the concept of preformation has not yet been so formulated as to satisfy the rigid demands of the scientist.

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FENDERS—Exceptionally handsome oval design.

RUNNING BOARDS AND FOOT BOARDS—Wood, linoleum covered and aluminum bound.

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EQUIPMENT—Electric Horn. Robe Rail License Brackets. Foot Rail. Tools. Demountable rim mounted on rear.

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